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APRIL, 1957

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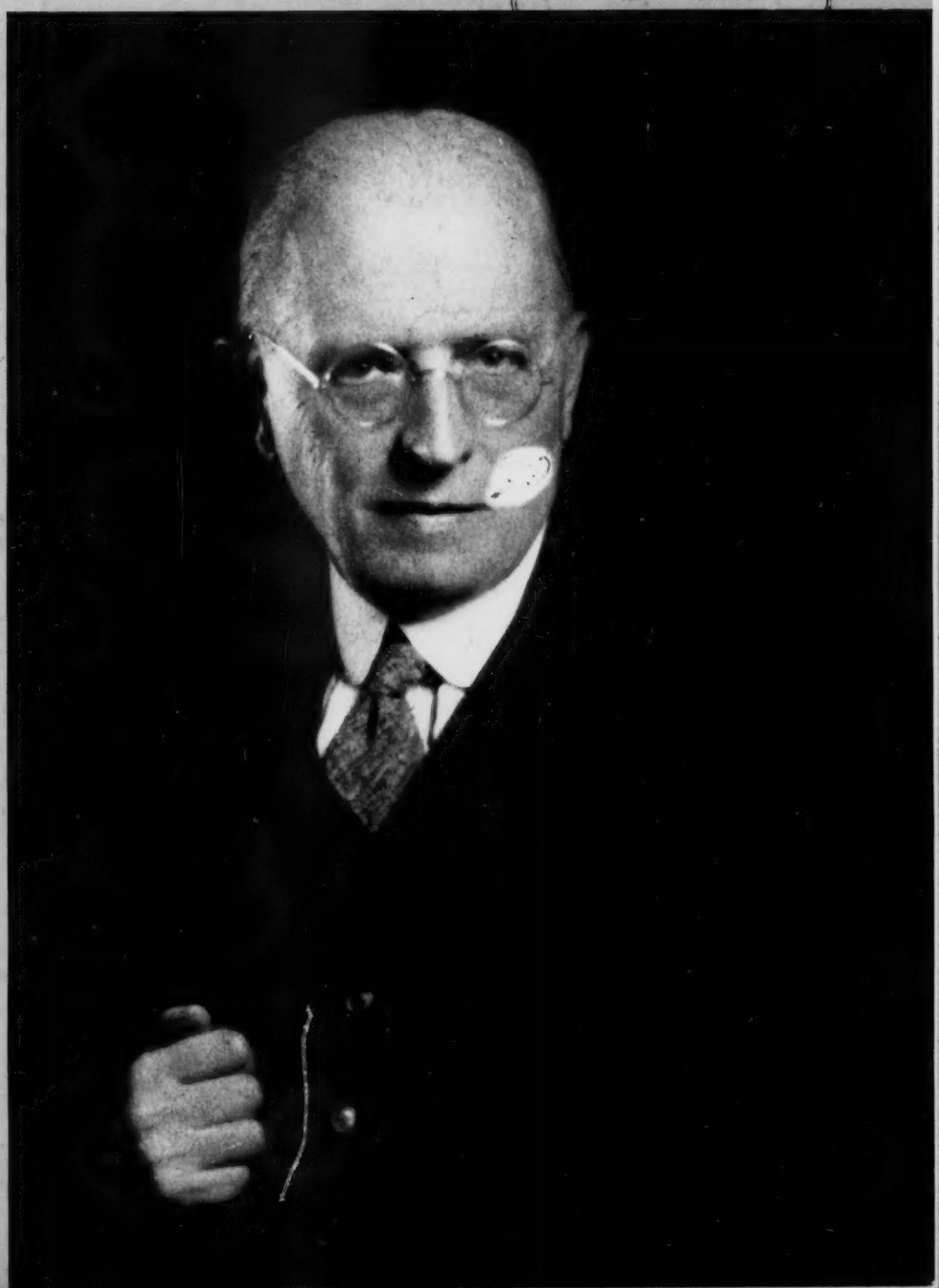
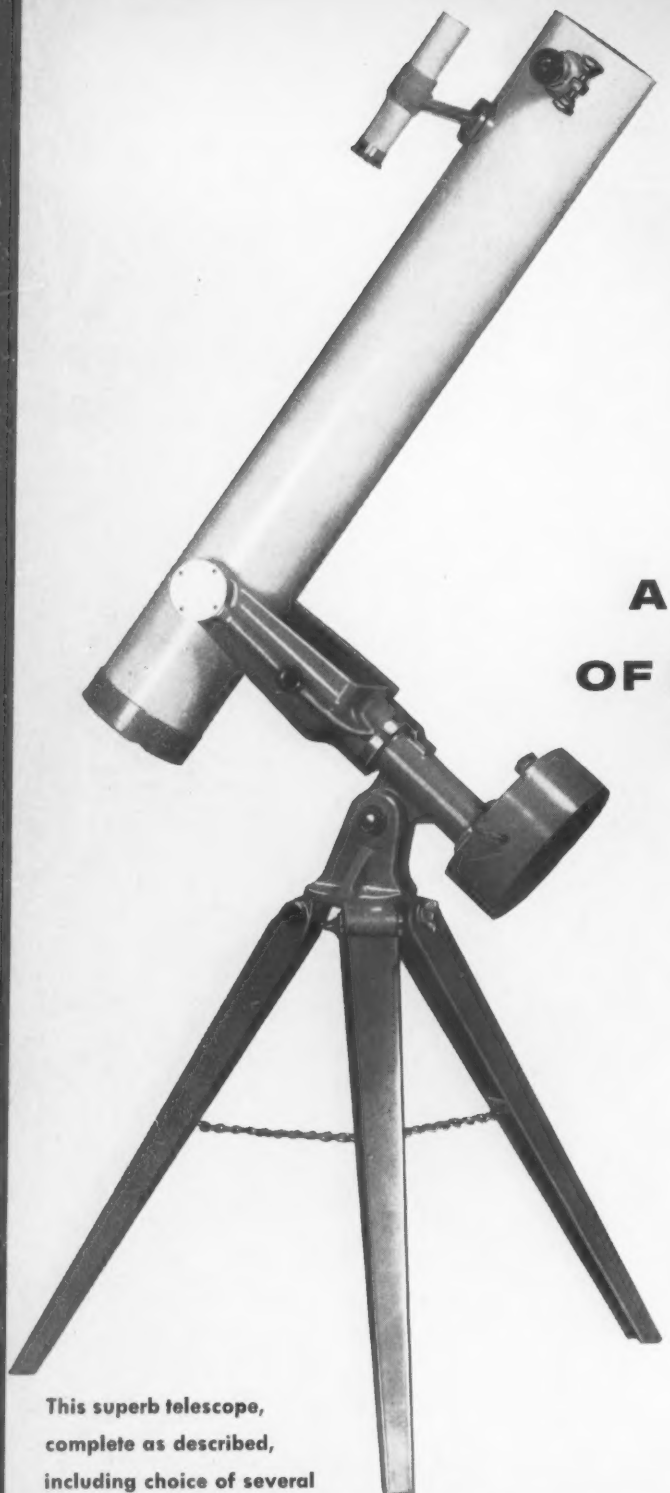


Henry Norris Russell
(1877-1957)



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Vol. XVI, No. 6 APRIL, 1957

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LETTERS

Sir:

Concerning the astronomical explanations of the Star of Bethlehem, discussed by Carl P. Richards in the December, 1956 issue (page 66), I suggested two years ago that Comet Finsler (1924c) might fit the known facts. This idea was published in *Miscellanea* No. 12 of the Capodimonte Observatory.

From the suggestive comparison of the orbital elements of Comet 1924c with those of the first comet observed in China for 10 weeks in the year A.D. 770, one can deduce that these comets were identical. The interval between these recorded returns is 1,154 years, into which a probable period of 385 years can be divided three times. If this surmise is right, Finsler's comet passed perihelion also in the years 1155 and 1540.

Subtracting twice the period from the date 770 brings us exactly to 0, whereas it is generally known that Christ's birth occurred five or more years before the beginning of the dating we now use. However, perturbations could change the perihelion passage by some years, as they have done for Halley's comet.

The dates of appearance and disappearance of the comet of 770, combined with the data of 1924, permit constructing a graphical orbit of the comet in 5 B.C. First it was in conjunction with the sun; then it became visible in the west after sunset. But thereafter it seemed to get closer to the sun, finally passing it and appearing in the morning sky.

A serious objection to this theory is that Comet 1924c was not seen brighter than magnitude 5, and thus was faint compared to the Star of Bethlehem. This could be explained by its progressive decay on each return to the sun, a phenomenon known to apply for certain other comets.

ALFONSO FRESA
Capodimonte Observatory
Naples, Italy

Sir:

Thanks to well-meant statements in certain books and publications, the American Meteor Society has been much embarrassed by hundreds of requests for charts and other information. Our charts are available only to members. Because of the prohibitive cost, we do not have photographs of meteors for distribution nor observing instructions suitable for children.

We have also refrained from accepting new members for this year due to a huge backlog of unreduced and unpublished data. However, we still welcome observations, particularly of fireballs, and will make all possible use of such information.

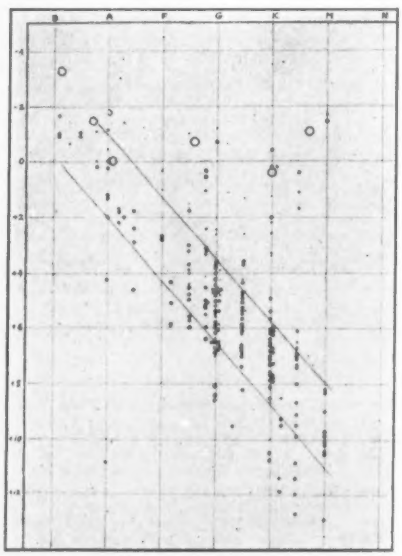
CHARLES P. OLIVIER, president
American Meteor Society
521 N. Wynnewood Ave.
Narberth, Pa.

On a visit to Harvard Observatory some 10 years ago, Henry Norris Russell discussed astrophysical problems with H. K. Sen. Dr. Russell died after a long illness, on February 18, 1957, at the age of 79. He was director of Princeton University Observatory from 1912 to 1947. Photograph by Robert E. Cox.

Dean of American Astronomers

HARLOW SHAPLEY

MANY PAGES would be needed to give a full account of Henry Norris Russell and his work. In brief space, however, I can record what seems to me of most significance, including his unswerving personal friendship, which was always spiced with useful criticism. But first of all, I should mention his impact on astronomical developments the world over. This may have been even more fruitful than his interpretations and theories.



The original basic Russell diagram of the spectrum-luminosity relation, plotting spectral classes against absolute magnitudes of stars for which trigonometrically measured distances were then known. The main sequence is outlined. Reproduced from the 1914 volume of "Popular Astronomy."

No one individual in American astronomy has ever equaled his influence throughout five decades as consultant on problems and programs. He grew up with astrophysics. At Princeton, at the Bureau of Standards, at Harvard and at the western observatories, he advised, computed, speculated, incited. He also grew up with eclipsing star theory, with modern thinking on planetary origins, and with the deduction of the masses of the stars; in fact, he fathered these developments.

Russell had been at Princeton, except for two years in England, all his adult career. "I had the good fortune," he once remarked, "to have a breakdown early in life." The consequence was that he knew his physical limitations and took care of his health for the succeeding five decades. Although he systematically had vacations by the sea and enjoyed traveling in Europe, his active mind was never far from the stars. His intellectual precocity was acknowledged by his amazed college instructors, who in 1897 graduated him *insigne cum laude*—the only time in recent Princeton history that this ultra-maximum honor has been granted.

To his students Russell was a terrific pacesetter, especially when it came to analysis. And what a memory he had—a quick glance at a page and he retained all its essential content. It would have been discouraging to the rest of us had he not kindly pretended not to notice our limitations.

His early postdoctorate years in England (1903-04) were devoted to work on stellar parallax, which was continued on his return to Princeton as an instructor. The studies of eclipsing variable stars began at about the same time that he was promoting his discoveries about giant and dwarf stars, and producing the famous diagram showing for the brighter stars absolute magnitudes plotted against spectra. His name is permanently associated with that of Hertzsprung in this magnitude-color array, which is the most used plot of data in current astronomical research. Russell admitted in my student days that he didn't know exactly the meaning of this H-R relation, and later enjoyed the student howler that the H-R diagram is the plot of H against R.

Throughout all his early years the work on stars and spectra was infiltered with considerations of the planets. One of his first published scientific notes dealt

ON THE DETERMINATION OF THE ORBITAL ELEMENTS OF ECLIPSING VARIABLE STARS. I

BY HENRY NORRIS RUSSELL

§ 1. *Statement of the problem.*—Bauschinger, in his exhaustive work on the determination of orbits, remarks concerning the problem of determining the elements of the orbit and the dimensions and brightness of the component stars of an eclipsing variable from the observed light-curve:[1] "Der Zusammenhang zwischen den Grossen-, Formen- und Helligkeitsverhältnissen der Körper und den Elementen der elliptischen Bahn einerseits und der Lichtkurve anderseits ist aber ein so komplizierter, dass man eine allgemeine Theorie wohl kaum aufstellen kann, sondern die Lösung von Fall zu Fall den vorliegenden Verhältnissen anpassen muss."

It is the purpose of the present discussion to show under what circumstances, and to what degree, this problem may be regarded as determinate (in view of the limited accuracy of photometric observations), and to develop formulae and tables which make the solution of the problem, when it is determinate, a simple matter.

In the most general case, the number of unknown quantities to be determined is considerable. The relative orbit will in general be eccentric, and the two components of the system unequal in size and brightness. They may present the appearance of disks not uniformly illuminated, but darkened toward the limb, and may also be elongated toward one another by their mutual attraction, and brighter on the side receiving the radiation of the companion than on that remote from it.

For a complete specification of such a system we must therefore know at least 13 quantities, as follows:

Orbital Elements		Eclipse Elements	
Semi-major axis	a	Radius of larger star	r_1
Eccentricity	e	Radius of smaller star	r_2
Longitude of periastron	ω	Light of larger star	L_1

[1] *Die Bahnbestimmung der Himmelskörper*, Leipzig, 1906, p. 542.

A reduced facsimile of the first page of the epoch-making Russell article on the analysis of light curves of eclipsing binary stars, which was published in the "Astrophysical Journal," XXXV, No. 5, June, 1912.

with the atmosphere of Venus. His planetary thinking was synthesized in a lecture series at the University of Virginia and in his very influential book, *The Solar System and Its Origin* (1935). But gradually his interest in the details of spectra grew into a permanent concern. Charlotte Moore Sitterly has written of his work in this field (*The Sky*, October, 1941, page 4):

"Dr. Russell . . . discussed the changes in intensity of atomic lines and molecular bands in stars of different temperatures. The culmination of this work is in the classical paper on *The Composition of the Sun's Atmosphere* (1929), which gives spectroscopically derived values for the abundance of 56 elements. More accurate analysis with the aid of modern measures is possible, but no published paper has yet approached this in completeness.

"In 1923, only the simple spectra had been analyzed. Demonstrations to students of laboratory spectra of the metals, when persistent bad weather prevented observation of the sun, made Russell realize the tantalizing attraction of the problem, and led to a series of investigations on spectrum analysis which still continue. Other workers have here been extraordinarily generous in communicating their observational results, and the collaboration has been correspondingly productive. In collaboration with Saunders, the spectra of the alkaline earths were interpreted. The spectra of scandium, titanium, vanadium, nickel, cobalt, lanthanum and europium—often in two stages of ionization—have been analyzed in collaboration with other workers."

All the appropriate medals and degrees, and other honors, came to Russell in due course, including the presidencies of the American Astronomical Society, the American Philosophical Society, and the American Association for the Advancement of Science. He didn't like these administrative assignments very much—"not my métier," he would say. It was more in keeping with his desires to sit across a table from a few eager students or associates and scribble ideas and make lightning-quick calculations. For several years he was a research associate at Mount Wilson Observatory and at Harvard Observatory. "He is the most important reflector in our whole equipment," one of his beneficiaries observed.

These are the buildings of the old Princeton Observatory, where Dr. Russell had his offices. The dome of the 9-inch refractor is at the left. Photograph by Dorothy N. Davis.

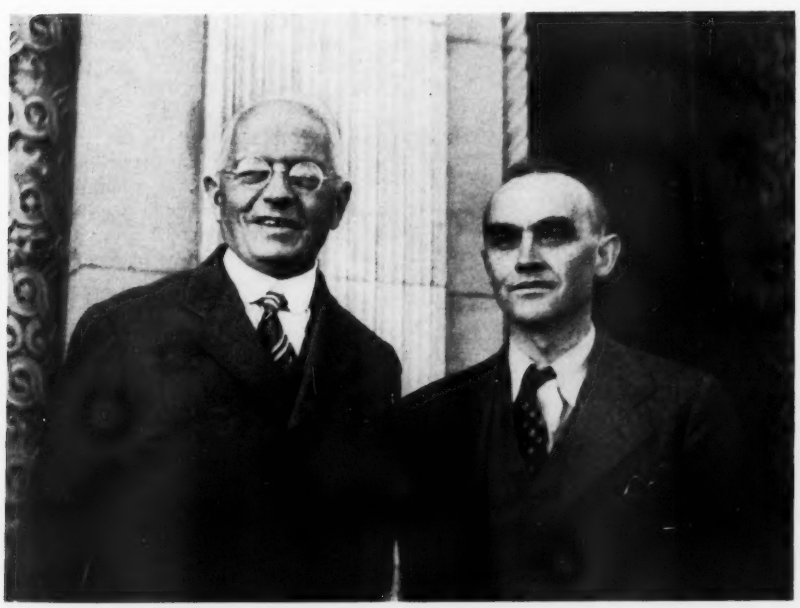
Russell's intellectual interests extended far beyond astronomy, especially during vacations. Religion, and its associated philosophy and science, appealed to him naturally; his father was a minister. And the Terry lectures at Yale in 1925, which resulted in the small volume *Fate and Freedom*, attested to his interest in religious philosophy. Ancient history and archeology also attracted him strongly.

We toured the Mediterranean together in 1922 on the way to the first full meeting of the International Astronomical Union. While still far from land we talked science. We got to speculating on international usages in astronomy and devised the three-letter system of designating the constellations—a project designed to save space in printing tables—which we later presented at the meeting of the IAU. Alpha Lyrae could be accommodated readily enough, but what about Alpha Canum Venaticorum? When the coast of Spain came in sight, Russell closed the dictionaries in which we were looking to see that none of our three-letter abbreviations would be improper in some other language, and he became forthwith a historian. He fought over the Carthaginian campaigns and later the Trojan wars. "That man Russell!" said the amazed Dean Charles Haskins of Harvard, a fellow voyager, "he could in a few months become America's foremost archeologist."

In a manner quite satisfactory to himself and his friends, Russell had completed his scientific work by the time his health began to fail a few years ago. His last research dealt with eclipsing stars—a return to the scientific attraction of his youth. One small paper is still in press.

The Yale citation in 1951 on the occasion of awarding him an honorary degree properly summarizes Russell's place in American science:

"Dean of American astronomers, profound student of the physics of the stars and the structure of the atom, master in the interpreting to us of the whole domain of astronomical research, philosopher of cosmic evolution and man's place in the universe."



Henry Norris Russell and Svein Rosseland, the Norwegian astrophysicist, photographed together at Yerkes Observatory in September, 1941, by Dorothy N. Davis, at a meeting of the American Astronomical Society.

The planetary nebula NGC 4361, as photographed by R. Minkowski with the 200-inch Hale telescope, in the red light of the hydrogen-alpha line. Mount Wilson and Palomar Observatories photograph.

Planetary Nebulae—II

OTTO STRUVE, *Leuschner Observatory, University of California*

LAST MONTH we discussed some recent studies of the planetary nebulae that show these great shells of gas to be unstable, expanding so rapidly their lifetimes are only a few tens of thousands of years. We shall continue with some of the ideas on the origin and evolution of the planetaries presented by the Russian astronomer G. A. Gurzadian in his 1954 book, *Dynamical Problems of the Planetary Nebulae.*

It must be pointed out that some of the material on which Gurzadian based his work is seriously out of date. His information on the structural details of the planetaries came from H. D. Curtis' collection of nebular photographs taken with the 36-inch Crossley reflector and published in 1918 in Volume XIII of the *Publications* of the Lick Observatory. Fine as the drawings and photographs in this work are, many have been surpassed by recent photography at Mount Wilson and Palomar Observatories by J. C. Duncan, R. Minkowski, and others.

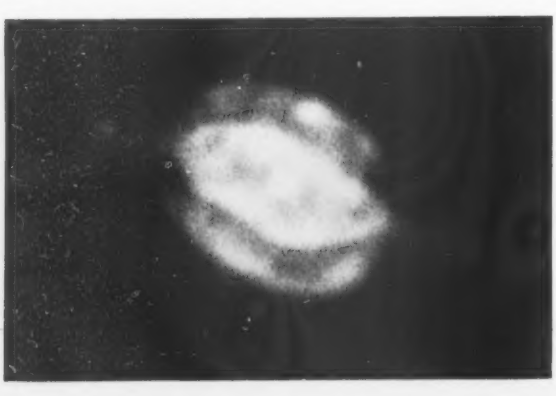
For the distances and dimensions of planetary nebulae, Gurzadian used the catalogue in B. A. Vorontsov-Velyaminov's book, *Gaseous Nebulae and New Stars.* These values have been criticized by L. H. Aller, because they are based on the incorrect assumption that planetaries share the rotation of the galaxy shown by *B*-type stars. We now know that the planetaries belong to Population II (old stars), while the *B* stars represent Population I (young stars). Hence, the distances and sizes cited by Vorontsov-Velyaminov should be regarded as very rough approximations.

On the other hand, Gurzadian has used the best available data for planetary expansion velocities, mostly those of O. C. Wilson described last month. Present rates of expansion are between 10 and 50 kilometers per second, very much smaller than the 1,000 kilometers per second typical of the expanding shells of old novae. But could the *initial* expansion of a planetary shell have been this rapid?

There can be little doubt that the outward motion of the gaseous shell is being slowed down. Three processes tend to decelerate it. The first of these is the gravitational attraction of the central star. The velocity of escape from the surface of the star is of the order of 1,000 kilometers a second. If the initial expansion were much under this value, the planetary could never have reached its observed size. If it started with this speed or a little more, by the time it became as large as we see it now the attraction of the star would have slowed the expansion to about 10 kilometers a second—about what we observe. But if the growth started at 1,500 kilometers per second, the outward velocity would still be about 1,100.

This would make it appear as if the initial velocity of all planetaries were almost identical with the velocity of escape from the central star. But there is no apparent reason for such near identity, and the behavior of exploding stars is by no means so consistent. Hence, it is believed that gravitational deceleration cannot alone explain the fact that *all* planetaries are expanding with low velocities.

A second cause of deceleration may be resistance by the interstellar medium. Gurzadian has shown that, as a first approximation, the ratio of the initial velocity to that at a distance r from the star is equal to $1 + 4r^3d/m$, where d is the density of the interstellar medium (say 5×10^{-24} gram per cubic centimeter), and m is the mass of the planetary (some 2×10^{32} grams or 1/10 the mass of the sun). Then, at a distance r of 10,000 astronomical units (1.5×10^{17} centimeters), the ratio of the two velocities would be 1.0003, or almost unity. It would require about 10 times as great a distance



Left: Compare this photograph of NGC 7009, in Aquarius, made with the 60-inch Mount Wilson reflector, with the Curtis drawing near the top of the facing page.

Right: This is the Curtis drawing of NGC 4361, from Lick photographs; it is the same object as pictured above by the 200-inch.

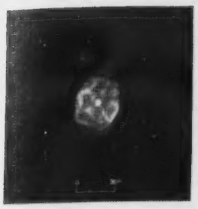


Fig. 68

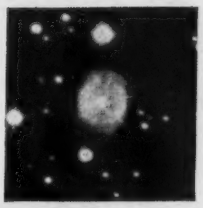


Fig. 68*a*

N.G.C. 6905; 20^h 17^m.9; +19° 47′

Exposures 5^m to 3^h. H.C.O. magn. 10.8 (total effect?). The central star is 14th magn. visually (Burnham) and 13th or brighter photographically. The main portion is a very patchy truncated ellipse 44″ × 37″ in p. a. 163°. Very faint cone-shaped ansae extend from each end. A star of magn. 12 lies nearly at the end of the southern ansa (not shown in drawing), but is probably not physically connected with the planetary. Moderately faint; the nebular matter just shows in 5^m on 823. Rel. Exp. 20.

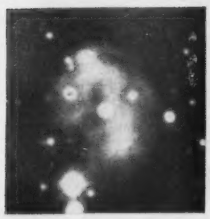


Fig. 69

N.G.C. 7008; 20^h 57^m.6; +54° 9′

Enlarged 11 times from a negative of 2^h 30^m exposure time. Central star magn. 12. Irregular ring structure indicated; the dimensions are 86″ × 69″ in p. a. 20°. The two brightest patches are at the north, and three stars which lie in roughly circular gaps in the nebulosity must either be physically connected with the nebula or, if nearer to us, be surrounded by absorbing atmospheres. Moderately faint. Rel. Exp. 20.

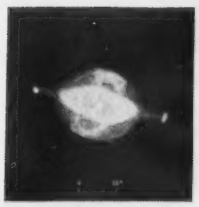


Fig. 70

N.G.C. 7009; 20^h 58^m.7; −11° 46

Exposures 10^s to 2^h. Central star of magn. 11 (Burnham, 12 visual). Of wonderfully intricate structure; the slightly oval central disk is about 30″ × 26″, while the almost stellar condensations at the ends of the ansae are 44″ apart in p. a. 79°. The inner ring shows considerable detail in the shortest exposures; in moderate exposures it is 25″ × 12″, and slightly fainter along its major axis. Exceedingly bright; the nucleus and inner ring show in 10^s on 827. Rel. Exp. 0.2.

Fig. 71

N.G.C. 7026; 21^h 2^m.9; +47° 27′

Exposures 30^s to 2^h 10^m. H.C.O. 11.4 magn. Central star of magn. 14. Very irregular; there are two bright lobes 5″ long in the shorter exposures symmetrically placed with regard to the central star, and about 6″ apart from center to center. A bridge of nebulosity connects these and involves the central star, so that it resembles the letter H. Irregular wisps extend from each end of this formation, making the total length about 25″ in p. a. about 10°. Fairly bright; the lobes show in 1^m on 827. Rel. Exp. 0.8.

The great variety in appearance and structure of planetary nebulae is illustrated by this reproduction of five of the H. D. Curtis drawings and photographs. His lucid descriptive captions are also included. From Volume XIII, "Publications" of the Lick Observatory, 1918.

from the central star to reduce the velocity of expansion to half its initial value. Thus it seems that the braking action of the interstellar medium is insignificant until the nebula has grown to very large dimensions.

The third factor is radiation pressure, resulting from the emission of Lyman-alpha radiation by hydrogen within the nebula, which causes the inner part of the shell to be decelerated. But this effect is also relatively small, as earlier studies by H. Zanstra and V. V. Sobolev have shown.

Taken together, these three braking actions can account for a moderate deceleration, perhaps by a factor of 2 or at most 10, but certainly not by a factor of 100. We must conclude that the initial velocity of expansion was of the order of 50 or 100 kilometers a second, and not 1,000. This small starting speed is, however, well below the velocity of escape from the star. Hence the gases that form the nebula must have been propelled by a force acting during an appreciable time interval (as in a rocket) and not by an instantaneous impulse (as for the case of a projectile).

Gurzadian explains this process in terms of the specific case of NGC 4361. As can be seen in the accompanying pictures, this is a peculiar spiral-shaped planetary, with a small, uniform inner patch around the central star, and a larger ring surrounding the two spiral features. From the shape of this nebula, Gurzadian decided that the outflow of gas must be more or less localized, coming mainly from two ends of a diameter of the inner spherical shell. The flow may actually be from two spots on the central star itself.

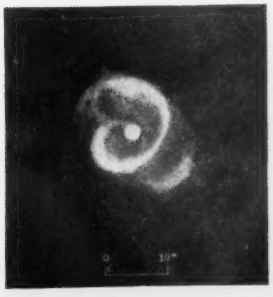
The radius of the inner disk of NGC 4361 is about 28,000 astronomical units or 4.2×10^{17} centimeters. From photographs we can estimate that the width of a spiral arm, where it meets the inner disk, is roughly 10^{17} centimeters, but this estimate may be incorrect by a factor of several times. Through this arm or "spout" we are assuming that gas is ejected at a velocity of about 100 kilometers per second and with a density of about 10^{-21} gram per cubic centimeter—about the average density of a planetary nebula.

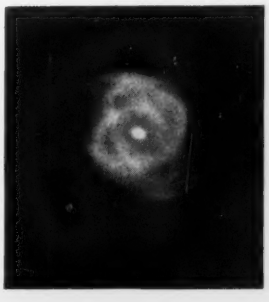
We can very roughly calculate the amount of material ejected in each second; it is the product of the cross section of the spout (8×10^{33} square centimeters) times the density times the velocity (10^7 centimeters per second). This amounts to 8×10^{19} grams per second, or about a millionth of the sun's mass in a year. To make up 1/10 solar mass, the typical planetary's total mass, the ejection from the two spouts would have to last some 50,000 years.

Thus the formation of a planetary nebula requires a much longer period than that of a nova shell, for which only a few days are needed. In the case of NGC 4361, our estimates of spiral arm sizes may be too small, and the density of the ejected matter may be larger than we have assumed. For the average planetary, the ejection may well last some 10,000 years, and even for those that evolve most rapidly it is hard to reduce the period of ejection below 1,000 years.

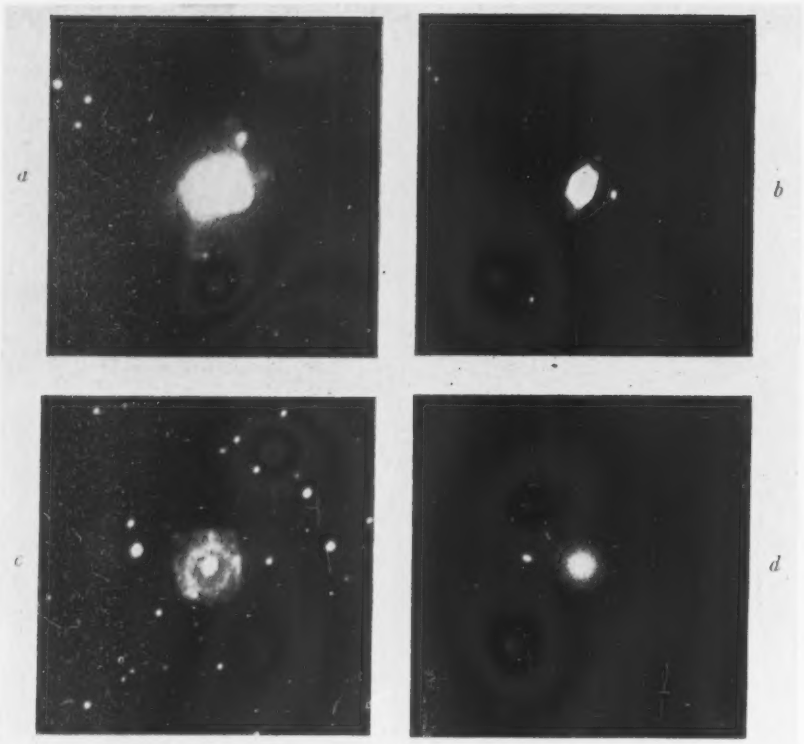
Note that 10,000 years is not the same as the time required to lift any given portion of the nebular mass beyond the dynamical barrier imposed by the 1,000-kilometer-a-second escape velocity from the surface of the central star. That portion of the star's material that becomes the planetary nebula needs to be lifted only to a height of a few hundred stellar radii (less than one astronomical unit) to reach a region where the escape velocity is below 100 kilometers per second.

The spiral structure of NGC 4361 is unusual but by no means unique among





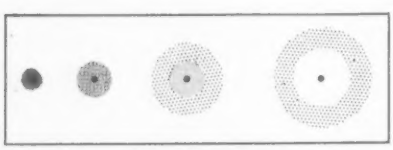
At the left is the Curtis drawing of NGC 6543, and at the right the same planetary recorded by R. Minkowski with the 200-inch telescope, on a night when the seeing was good. From Lick Observatory and Mount Wilson and Palomar Observatories photographs.



The first three of these pictures were taken by John C. Duncan with the 100-inch telescope, the fourth (d) with the 60-inch. The telescopes were used at full aperture and with aluminized optics. All are to a scale of two seconds of arc per millimeter: (a) NGC 6210 in Hercules, June 25, 1936, 35-minute exposure; (b) IC 4634 in Ophiuchus, July 12, 1937, one-hour exposure; (c) NGC 6751, Aquila, July 12, 1937, 20-minute exposure; and (d) IC 3568, Camelopardalis, August 2, 1937, 10-minute exposure. The last is an excellent example of a double-ring planetary. Reproduced from the "Astrophysical Journal."

planetaries. To explain this appearance, Gurzadian suggests that the spiral arms lie approximately in the equatorial plane of a slowly rotating central star, whose axis of rotation is nearly in the line of sight.

The stream velocity of the jet flowing from the spout decreases because the stream widens outwards; this effect is in addition to the braking actions discussed above. As the outward velocity slackens, the sidewise motion of rotation causes the stream to curl around in the form of a spiral whose outer portions gradually approach a circular ring. From the shape and size of the spiral structure in NGC 4361, Gurzadian has computed that the rotation period of the star is about 400 years. Although his hydrodynamical calculations may be somewhat uncertain, the star must rotate exceedingly slowly if his proposed model of this planetary is correct.



The possible evolution of an expanding planetary nebula, according to G. A. Gurzadian, who suggests the third stage is observable as a double ring.

Other planetaries showing spiral arms, according to Gurzadian, are IC 320, IC 4634, NGC 6210, NGC 6587, NGC 6881, and NGC 6886, but for these the structure is less obvious. Other cases, which he calls "zeta-type" planetaries, are NGC 2452 and NGC 6778, while he describes NGC 6543 as "snail-type." Gurzadian believes that in each of these objects the fundamental mechanism is the same as in NGC 4361. In the zeta-type planetaries, the drastic bending of the streams is attributed to a rapid outward decrease in density, due to interaction with interstellar material. In all these cases he believes the periods of axial rotation are to be counted in hundreds of years. This is a most unexpected result; the rotation periods of normal stars range between a few hours (Phi Persei) and a month (the sun).

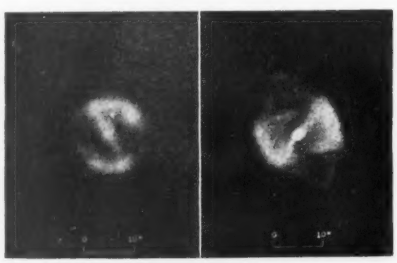
From entirely different considerations, C. F. von Weizsäcker, the present writer, and several other astronomers have suggested that young stars (Population I) have fast rotations and old stars have slow rotations, as a rule. Several processes have been suggested (the best by H. Alfvén) by which the rotation of an aging star would become slower. But whether any of these processes can virtually arrest the rotation of a star remains to be seen. In any case, a simple observational check on Gurzadian's result could be easily made by comparing the orientation of the streams as photographed at Lick Observatory some 40 years ago and as they appear at the present time.

Some of the more conventional ringlike planetaries have a faint outer ring of about twice the diameter of the brighter inner ring. Among the best photographs of the double-ring planetaries are those made by Duncan at Mount Wilson, of which some examples are reproduced here. It is scarcely logical to attribute the rings to two outbursts of the central star separated by some thousands of years: Why should there be almost invariably just two rings, and not three or more? Why should the mass of the outer rings always be a small fraction (about 1/10) the mass of the inner? And why does the more rapidly expanding inner ring not sweep up the less dense and slower-moving outer shell? Gurzadian suggests that the latter ring owes its existence to the outward radiation pressure from the original shell. This occurs when the latter becomes sufficiently transparent, on attaining a diameter of about 25,000 astronomical units. Thus, the evolution of a typical ring-type system would proceed as schematically shown in the diagram. The outer ring becomes invisible first, so at the end of the sequence only a single ring is observable, with very little gas inside it.

While these ideas of Gurzadian are novel and stimulating, they are also highly controversial. At Palomar Observatory, Minkowski has obtained a superb series of direct photographs of planetaries, a few of which accompany this article. He has recently told me that he is not certain the spiral forms are real, although he does not deny the possibility of their existence. He points out that it is often difficult to distinguish between a spiral and parts of two circular rings whose centers are slightly displaced.

Compare the two pictures of NGC 4361 on page 262; one is by Minkowski with

(Continued on page 275)



These Lick drawings by Curtis illustrate Gurzadian's zeta-type planetaries, NGC 2452 at the left, and NGC 6778 at the right. Curtis noted the hourglass shape of the latter, and the faint ansae above and below the main part of the planetary.

ASTRONOMICAL SCRAPBOOK

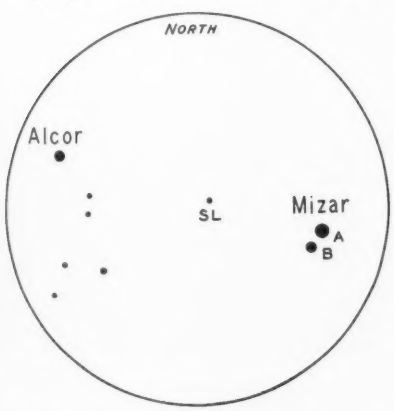
The Field of Mizar and Alcor

ONE of the richly storied stars in the sky is Mizar, the next to the last bright star in the handle of the Big Dipper. To the naked-eye observer, it attracts attention because of its close 4th-magnitude neighbor, Alcor, distant only 11 minutes of arc or a third of the full moon's width.

Alcor is so easily seen without optical aid that it is surprising to hear the often repeated tale of the ancient Arabs regarding it as a test of acute vision. Does anyone know the original authority for this statement? It sounds suspiciously like some blunder uncritically copied from book to book and kept alive by repetition.

Mizar holds a unique place in double star astronomy. It appears to have been the first double discovered with a telescope, around the year 1650, by the Italian astronomer Giovanni Battista Riccioli. Even a very small telescope and modest magnification will split Mizar into two stars of the 2nd and 4th magnitudes, 14 seconds of arc apart. This pair was also the first double star photographed, when George P. Bond in 1857 secured a successful impression of it on a collodion plate with the 15-inch Harvard refractor.

The brighter component of the pair—Mizar A—was also the first spectroscopic double star detected. In 1889 Antonia C. Maury noted on Harvard Observatory photographs of its spectrum that the lines appeared sometimes double and sometimes single. This phenomenon indicated that Mizar A was a binary, its components being nearly equal in brightness and revolving around each other in a period later shown to be 20.5 days. The new companion—Mizar a—is much too close to A to be made out visually with even the largest telescopes. In fact, when in 1925 F. G. Pease measured the spectroscopic pair at Mount Wilson Observatory, with a 20-foot interferometer attached to the 100-inch reflector, the distance between the two stars was only about 0.012 second of arc.



The Mizar-Alcor field, as it appears in a low-power telescope with a field of view about 17 minutes of arc in diameter. SL denotes Sidus Ludoviciana, once called a planet.

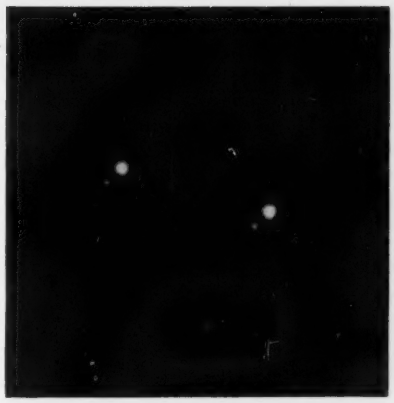
Mizar is thus at least a triple system. The visual pair AB has remained almost unchanged in the three centuries it has been known. The very slow increase in position angle indicates that orbital motion in this pair requires many thousands of years. At the distance of the Mizar system, about 70 light-years, their projected separation of 14 seconds corresponds to about 28 billion miles, or 10 times as far as Neptune is from the sun. The interferometer measures indicate that the spectroscopic pair has a separation half that of the sun and Mercury.

Moreover, in a sense Alcor is connected with the Mizar system, for it is one of the few dozen other scattered stars that form the Ursa Major moving cluster—stars traveling together through space much like a flight of wild geese.

Is there yet another component in the Mizar system? This question was raised in 1939 by the French astronomer G. Oriano. On comparing the very numerous micrometer measurements of the AB pair made since 1822, he believed he had found a 57-year oscillation in the relative location of these two stars. This effect he attributed to an invisible companion moving around one of them, probably B, in an orbit presented almost edgewise to us. So nearly on edge was it thought to be that A. V. Nielsen in Denmark suggested that Mizar B might even be an eclipsing variable star. He cited a curious half-forgotten observation in support of this conjecture.

The Berlin amateur, J. H. Mädler, well known for his lunar and planetary observations, in 1840 was appointed director of the university observatory at Dorpat, Russia. He was successor to the famous Wilhelm Struve, who had gone to Poulkovo Observatory. Mädler became a very active double star observer with the Dorpat 9.6-inch refractor. On April 18, 1841, he turned this instrument on Mizar just before sunset, and to his great surprise found no trace of the B component. It should have been seen, for check observations on other doubles showed even fainter stars readily. Later the same night Mädler looked at Mizar again, and B was once more shining with full brilliance. He commented that this behavior could be explained if Mizar B were a variable star of the Algol type, but with a much longer period.

Moreover, this Mädler observation was made at a time when Mizar B and its hypothetical companion were practically in the same line of sight, according to Oriano's orbit. But the neat picture contains a fundamental defect.



Just a century ago, on May 8, 1857, these two pictures of Mizar were taken by George P. Bond at Harvard.

If we intercompare the very accurate photographic measurements of the double star Mizar AB made over the last four decades, there is no indication of Oriano's 57-year oscillation. He had depended on the much rougher visual measurements, which are affected by systematic errors for which he made no allowances. Probably they account for his result. Even though we put Oriano's discussion to one side, however, Mädler's strange observation remains an unsolved puzzle, a small skeleton in the astronomical closet.

Nearly midway between Mizar and Alcor is an 8th-magnitude star which is known as Sidus Ludoviciana, although it is most unusual for an ordinary star this faint to be known by other than some catalogue number. The name was given two centuries ago by J. G. Liebknecht, who was professor of theology and mathematics at the German university of Giessen. (One of his books, dated 1721, was *Pharus, or a Dissertation on Fiery Wonders in the Sky, Collected from Every Age*, which sounds rather like an early treatise on flying saucers.)

On December 2, 1722, Liebknecht was exploring the heavens with a nonachromatic refractor six feet long—not much of a telescope even in those days—when he chanced upon this star. He thought it a new object, and from some inaccurate measurements of its position decided that it was in motion. Believing himself the discoverer of a new planet, he named it Sidus Ludoviciana after his sovereign, the Landgrave Ludwig of Hessen-Darmstadt, and wrote a pamphlet announcing his find, sending copies to all the leading astronomers of Europe.

Their reaction was unfavorable. L. Zumbach von Koesfeld, then a prominent astronomer, physician, and musician of Kassel, announced that Liebknecht's measures were too crude to warrant any trust. In a further pamphlet, J. F. Weidler of Wittenberg told how he had looked at Mizar with a superior telescope 22 feet long on four nights in February, 1723,

(Continued on page 270)

MARS SYMPOSIUM

DURING the December meeting of the American Astronomical Society and Section D of the American Association for the Advancement of Science, a symposium was held on "The Recent Close Approach of Mars." The speakers were R. S. Richardson, Mount Wilson and Palomar Observatories; C. C. Kiess, National Bureau of Standards; C. H. Mayer, Naval Research Laboratory; Seymour L. Hess, Florida State University and Lowell Observatory; and G. P. Kuiper, Yerkes and McDonald Observatories. The chairman of the symposium was Dr. Fred L. Whipple, Harvard Observatory. The meeting was in New York.

AT Mount Wilson Observatory, Dr. Richardson was engaged in three kinds of Martian observations: direct photography at the Cassegrainian focus of the 60-inch reflector, high-dispersion spectrography, and photography of the satellites with the 60- and 100-inch telescopes. He had telescope time on 36 nights from May 15th to December 16th, losing only two by cloudiness, and observed for a total of 110 hours.

The opposition of 1956 was not a favorable occasion for observations of the Martian markings called canals. Previous experience has shown that the development of the canal system in the southern hemisphere of the planet is most marked shortly after the Martian vernal equinox. However, "April" on Mars came in May, 1956, long before opposition and while the planet was still distant.

Dr. Richardson saw the canals on only two occasions. The first was at the 60-inch on the morning of June 3, 1956, although Mars was still 74 million miles away. Many light blue lines—of the same color as the maria—were visible crossing the red sections of the planet's disk. The seeing was fine, but photographs that morning did not show the canals on exposures of $\frac{1}{3}$ to 20 seconds, although the planetary image was 13 millimeters in diameter.

The other canal observation was made on October 10th, at the coude focus of the 100-inch. The canals Simois and Thermadon on the far southern part of the disk were distinctly visible for a second or two in only fair seeing. Next night, the maria appeared light green or gray green to Dr. Richardson; from June 3rd to September 11th they had looked slate blue.

The Mount Wilson astronomer obtained successful photographs of Phobos and Deimos, the tiny satellites of Mars, but he reported that his measurements of the plates were not completed.

Marked cloudiness in Mars' atmosphere that was presumably caused by dust storms set in by August 30th and continued through the date of opposition. There seemed to be no blue clearing, although Dr. Richardson pointed out that his record was not continuous; his blue photographs revealed just a uniform disk and the polar caps. In July the rift in the south cap was visible on photographs in yellow light, but not in blue light.

One of the spectrographic problems involved the nature of the blue haze. At short wave lengths (violet, blue), the Martian atmosphere is normally opaque; in the yellow and red it is transparent. At what wave length does the cutoff occur? Dr. Richardson found it to be near 4420 angstroms.

Another purpose of the spectrographic program was to see if the 7820 band of carbon dioxide could be recognized. (Dr. Kuiper several years ago had found spectroscopically that this gas is present on Mars.) Dr. Richardson made extensive observations with the 100-inch coude spectrograph, dispersion 5.6 angstroms per millimeter, on infrared plates. No trace of this band was found, although check observations showed it to be conspicuous in the spectrum of Venus.

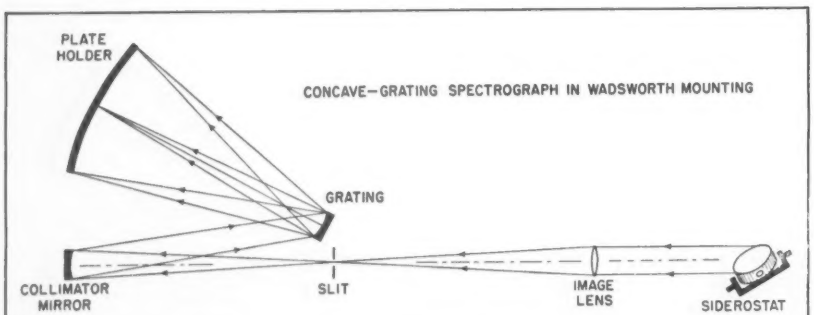
Evidence of oxygen and water vapor, two important constituents of terrestrial air, has long been sought in the spectrum of Mars' atmosphere, but without success. Dr. Richardson looked for the absorption bands of these gases corresponding to the terrestrial *B* and *a* spectral features. During his season of observation, the line-of-sight velocity of Mars changed from −8.9 to +14.9 kilometers per second. On December 16th, therefore, the Doppler shift for Mars should have displaced the planet's spectral lines by 0.22 angstrom with respect to the telluric features in the red part of the spectrum—0.07 inch upon Mount Wilson plates. Inspection of the plates did not show Martian *B* and *a* bands, but microphotometer tracings were still to be made.

A SIMILAR search for Martian atmospheric gases was made by a four-man expedition to Hawaii in July, 1956, under the leadership of Dr. Kiess and the sponsorship of the National Geographic Society. After their equipment had been tested by observations of Jupiter at Georgetown College Observatory, it was transferred to Mauna Loa Observatory, 11,134 feet above sea level. The powerful spectrograph was used with each of two concave gratings, having 15,000 and 30,000 lines per inch and giving dispersions of five and two angstroms per millimeter, respectively, for the first-order spectrum.

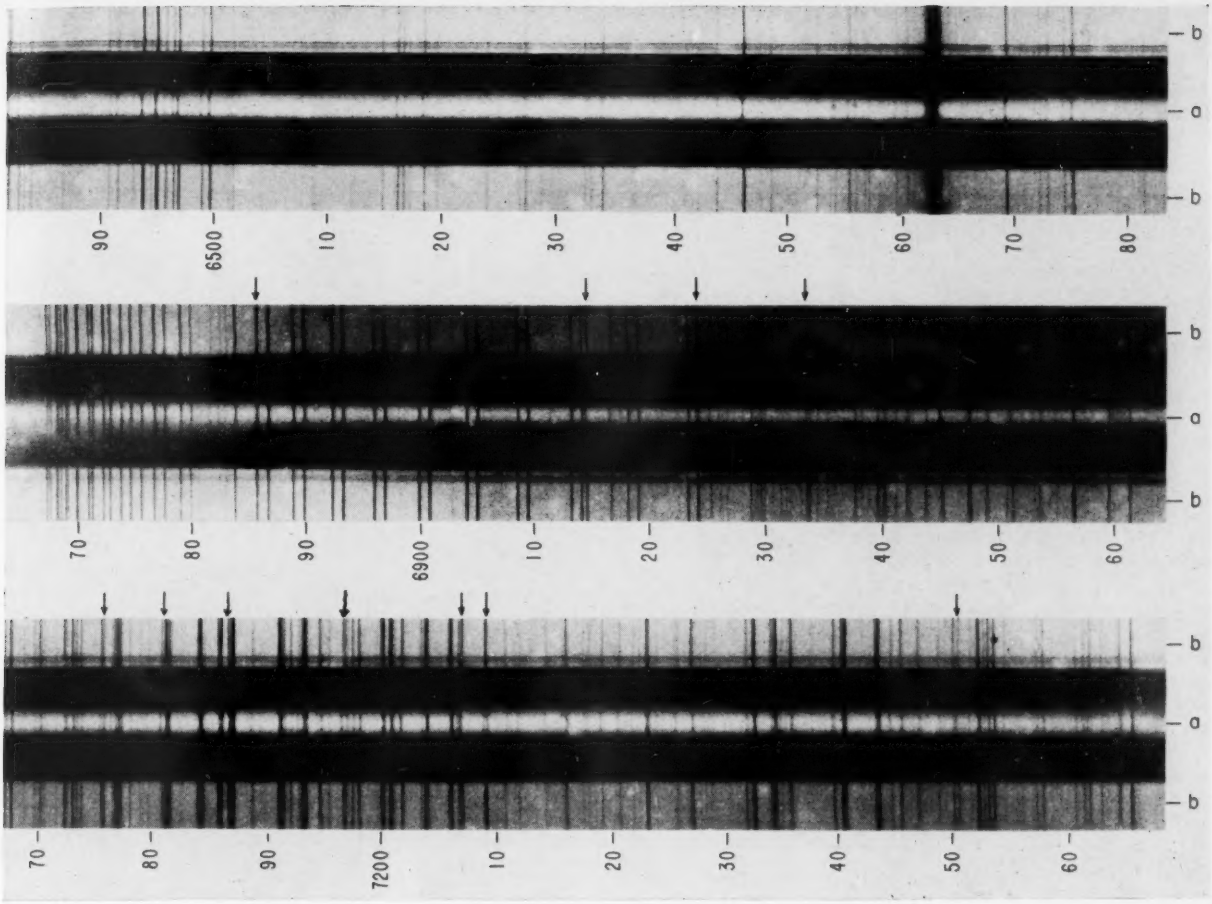
The accompanying spectra of Mars and the moon both contain, in addition to the absorption lines of the solar atmosphere, the telluric lines added by the earth's atmosphere. The solar lines in the Martian spectrum, however, are shifted by the Doppler effect of Mars' relative motion, and so are recognizable. Except for the telluric lines, these regions of Mars' spectrum appear identical to their counterparts in the lunar spectrum.

Thus, despite the power of this equipment, no indication was found of water vapor, molecular oxygen, or atomic nitrogen in the Martian atmosphere. An upper limit to the possible amount of water vapor was subsequently set by laboratory tests with the same spectrograph, used with a 40-foot air path near sea level. In its entire atmosphere, Mars cannot have more water vapor than could form a film 0.08 millimeter thick if condensed to liquid on the planet's surface.

A future, more sensitive test than any hitherto applied for Martian water vapor was proposed by Dr. Kiess. This is the in-



To obtain spectra of Mars such as those reproduced on the opposite page, the National Bureau of Standards expedition took a grating spectrograph to the Mauna Loa Observatory, in Hawaii. The optical setup is illustrated here, Mars' light being collected by the siderostat mirror at the right.



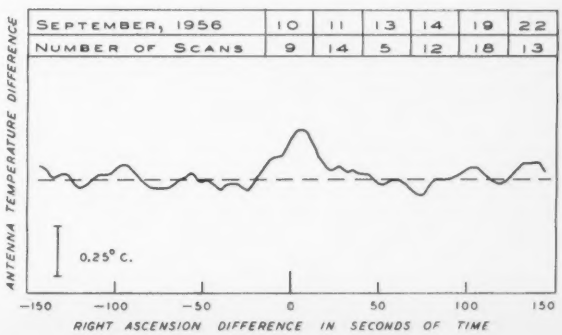
The National Bureau of Standards expedition to Hawaii secured these high-dispersion spectra of Mars (a) and the moon (b). The wave lengths are marked in angstroms. The top group includes the intense hydrogen-alpha absorption line at 6563 angstroms; the middle group contains paired lines belonging to the B-band of molecular oxygen in the earth's atmosphere; the bottom spectra cover the a-band of water, H_2O. Other lines originate in the sun's spectrum, which is reflected by the moon and Mars, but the motion of the planet relative to the earth-moon system causes Mars' spectrum to be somewhat displaced; a few such cases for solar lines are indicated by the arrows. Any lines added by absorption in Mars' own atmosphere would be similarly shifted, but there are no such lines for either the B-band pairs or the a-band, indicating the rarity of oxygen and water vapor on Mars. National Bureau of Standards photograph

frared absorption band at 1.4 microns, which should be more than 200 times as strong for the same quantity of water vapor.

SINCE Mars' close approach of 1941, the science of radio astronomy has made tremendous strides, and in 1956 the detection of microwave radiation from Mars marked a major broadening of the observational attack on the red planet. This discovery was made at the Naval Research Laboratory (*Sky and Telescope*, November, 1956, page 17); at the symposium Mr. Mayer gave additional details of the work he has been doing with T. P. McCullough and R. M. Sloanaker.

From September 9th to 22nd, about 125 scans across the sky area surrounding Mars were made with the 50-foot radio telescope, at a wave length of 3.15 centimeters. When the best 100 scans were averaged, a slight but definite increase in intensity was evident from the direction of the planet, corresponding to a rise in antenna temperature of 0.24 degree centigrade.

The observed radiation is almost certainly thermal emission from the planet's surface. If Mars radiated as a black body, the radio intensity would correspond to a temperature of 230° Kelvin, but this is only a lower limit. The actual surface temperature should be higher because Mars radiates less efficiently than a black body would.



The central peak of this curve shows a $\frac{1}{4}$-degree rise in antenna temperature as Mars passed through the field of the 50-foot radio telescope at the Naval Research Laboratory. The curve is an average of 71 scans.

INTERNATIONAL co-operation in the observation of Mars, encouraged by the Mars Committee as early as 1953, was carried out in 1956 as well as in 1954. Dr. Hess stated that full reports on the international photographic patrol had not been received, so no analysis of the 1956 work could be offered yet, but the operation was on about the same scale as in 1954, when some 10 observatories participated. At the close approach of the

planet last year, observers joined in a systematic cloud patrol to obtain visual observations of Martian clouds, from which winds could be determined. Many cloud reports had been received, with more expected. One of the most striking clouds was seen from August 16th to 26th by Japanese observers. It had a well-marked drift averaging eight miles per hour. Probably this should be interpreted as the travel speed of a storm center, rather than the velocity of the winds themselves.

At Lowell Observatory, the observers noted the extraordinary lack of contrast on the planet's disk during this opposition, an appearance culminating in the great dust storm of August 30th, which blotted out much detail and obscured the south polar cap, even on red plates!

As in 1954, under the sponsorship of the National Geographic Society, E. C. Slipher went from Lowell Observatory to Bloemfontein, South Africa, to work with the 27-inch Lamont-Hussey refractor. His observations continued so long he could not return in time for the New York symposium. Dr. Hess reported that Dr. Slipher took 38,000 images of Mars in 1956, and also found the famous "W" of 1954 briefly detectable.

Occasionally the blue haze of Mars' atmosphere clears away for a few days, close to the date of opposition, only to form again, planet-wide. Filling out the report by Dr. Richardson, the Lowell observers found two periods of partial clearing, about 10 days before opposition and about 10 days after, from a preliminary inspection of their photographs. Dr. Hess, in a separate paper at the meeting, described theoretical studies of the blue haze phenomenon in which he utilized the methods of terrestrial meteorology.

The blue haze cannot consist of dust particles, for they could not settle out rapidly enough to produce the abrupt clearing that usually occurs. Hence, they are evidently ice grains, almost certainly frozen water rather than frozen carbon dioxide, according to Dr. Hess.

The decision in favor of water comes from his calculations of the optical properties of Martian clouds, on the assumption that Mars' atmosphere has thorough vertical mixing, with a temperature drop of 3.7 degrees centigrade for each additional kilometer above the planet's surface. The surface temperature at the subsolar point is taken as +10° C.

Dr. Hess' computations show that solidified carbon dioxide clouds would be far more opaque than the blue haze is actually observed to be, while water ice clouds can explain the properties of the haze. However, the latter clouds may exist only if the dew point at the Martian surface is about −90° C., indicating an exceedingly dry atmosphere. If all the water content corresponding to such a dew point were to be precipitated evenly over Mars' surface, it would form a layer only 0.002 millimeter thick. This is far less than could have been detected spectroscopically by Dr. Kiess' expedition.

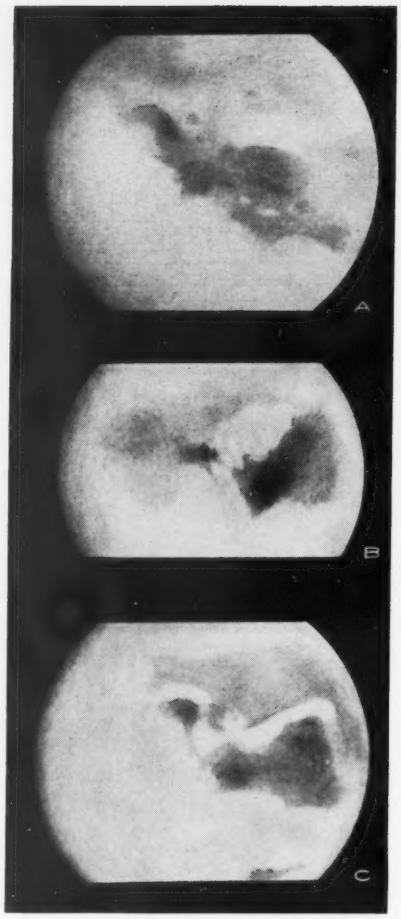
DR. KUIPER described his observations of Mars with the 82-inch reflector of McDonald Observatory in Texas. While some views were obtained in June and late fall, his work was done mainly from mid-August to mid-September, under six headings:

1. A visual study of the colors of dark areas. He compared the color, as seen in a 900x binocular eyepiece, with a chart exhibiting 200 hues, which was placed three feet from the observer and was illuminated by light of sunlight quality.
2. Surface detail.
3. Color photography.
4. Measurements of the diameter and oblateness of Mars.
5. Satellite photography for positions.
6. Satellite photoelectric photometry for magnitudes and colors.

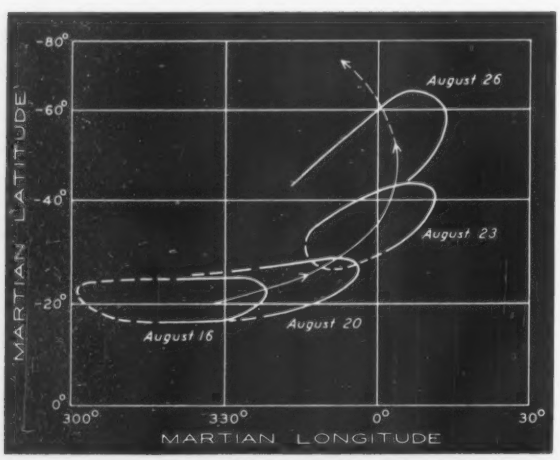
Two sets of Martian maps were used as references, those of E. M. Antoniadi's book on Mars, and an unpublished series by G. de Mottoni, one for each Mars opposition since 1939, based on Pic du Midi Observatory photographs. The latter maps are less detailed than those of Antoniadi, who laid down all the details he had ever seen at one time or another, but the de Mottoni maps corresponded very well with the observations of Dr. Kuiper.

Although early in his career Antoniadi believed he saw narrow canals, in 1909 he reversed this opinion and thereafter drew not fine, linear markings, but broad, diffuse streaks. Dr. Kuiper could not in general confirm Antoniadi's abundant streaks, and sometimes these turned out to be merely boundary lines between unequally bright desert regions.

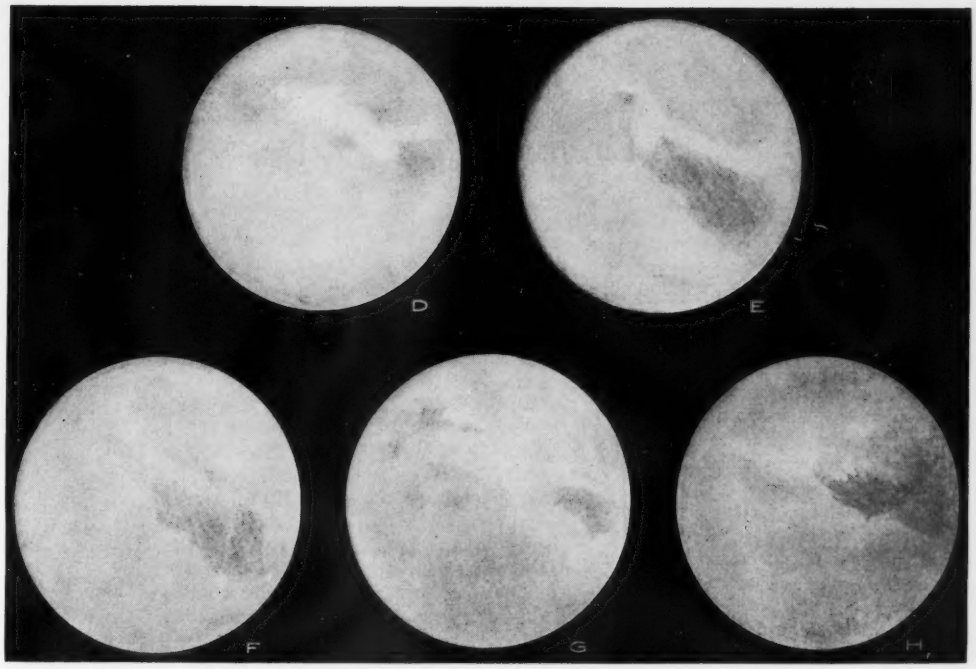
With the 900x binocular eyepiece, the



Three stages in the development of a remarkable disturbance in the Martian atmosphere, as drawn by G. P. Kuiper with the 82-inch McDonald reflector. Sketch A shows the central portion of Mars on August 29, 1956, at 8:00 UT, before the storm started. Mare Sirenum is the "beak" to the left, and Mare Cimmerium is the large dark area right of center. In B, at 7:30 UT the next night, the same features are shifted about a fourth of Mars' diameter to the right. A dust storm has developed over the central part of Mare Sirenum, and five bright clouds are seen in the dusty area above Mare Cimmerium. In C, August 31st, at 8:30 UT, the dust storm has stretched into a giant "W," but the center of the disturbance is still over Mare Sirenum. All 13 drawings on this and the facing page are courtesy of Dr. Kuiper and the "Astrophysical Journal."



The drift of a yellow cloud across the Martian surface between August 16 and 26, 1956, has been plotted by S. L. Hess from Japanese observations collected by Dr. Issei Yamamoto.

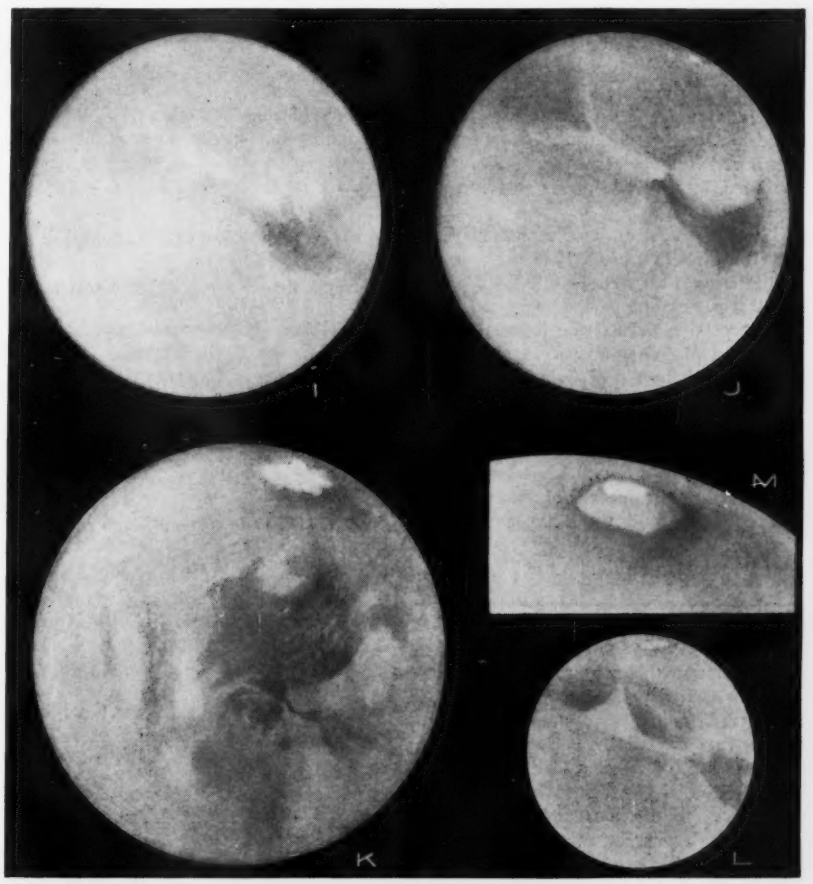


The increasing extent of the Martian dust storm is evident in these later drawings by Dr. Kuiper: D, September 1st, 6:50 UT; E, same night at 9:40 UT; F, September 2nd, 9:50 UT; G, September 3rd, 7:50 UT; and H, the same night at 9:45 UT. Drawings E and F show the same parts of Mars as A, while G matches D, with H corresponding to B.

Martian image was six degrees in apparent diameter, and it was continuously steady when the seeing was fine. There seemed to be a correlation between the quality of seeing and the apparent color of the dark markings. When the seeing is poor, the observer's eye wanders over the planet, and subjective colors result from contrast phenomena. This spurious effect is reduced when the conditions are excellent and the Martian areas are viewed steadily. An important further precaution during the color work was to have the dome illuminated so the observer's eye was light-adapted rather than dark-adapted.

Dr. Kuiper found that the basic color of the dark markings is a "neutral gray." By this he means that to a first approximation, and after allowing for the atmosphere, the dark regions have the same basic color as adjacent deserts, but diluted with black. There are some slight but real differences from one dark area to another. Those near the pole have a slightly brownish tinge (as Antoniadi had found), whereas dark areas near the equator have no hint of brown, but a very dilute trace of moss green. This tint was shown most clearly by the Thoth-Nepenthes band. The desert areas also differ appreciably among themselves in tint, and viewing through a red filter accentuates these differences.

Some Russian observers had reported that the polar caps share the ocher hue of



Five further drawings of Mars in 1956, by Dr. Kuiper with the 82-inch telescope. Sketch I was made September 4th, at 9:30 UT, and J the next night at 9:35 UT. Both show the same face of Mars as D. Note in J the very small polar cap at the upper-right edge of the planet. K, drawn on September 9th, 6:00 UT, shows a new cloud over the south pole, and there are several dust storms invading the dark equatorial regions. L, on the 9th at 11:20 UT, represents the same parts of Mars as I and J. Drawing M, made September 14th at 7:15 UT, is of the neighborhood of Mars' south pole. There is a new surface deposit, heavier in the bright inner cap; the dark zone surrounding the polar cap appeared slightly brownish to Dr. Kuiper.

the greater part of the disk. From his color-chart comparisons, however, Dr. Kuiper found that the south cap is almost a pure white. This is also true for detached portions of the cap.

In three drawings, the Yerkes astronomer illustrated a novel behavior of the south cap. On September 9th, after it had shrunk to nothing, a cloud pack some 800 miles in diameter formed over where the cap had been. This array of cloud condensations was seen again on the 10th and 12th; but on the 14th they had cleared away and a new polar cap was visible. By its sharp edge, the new cap could be distinguished from a cloud condensation.

In the general discussion following the symposium, Dr. Kuiper pointed out the significance of his unsuccessful search for ozone in the Martian atmosphere, many years ago. Suppose an atmosphere contains both molecular oxygen and ozone; then, if the oxygen content is reduced, the ozone concentration decreases much more slowly. Thus observations of the intensity of ozone bands can afford a very delicate test for small amounts of oxygen in a planetary atmosphere.

One of the primary problems in the interpretation of Martian features is whether or not the planet supports life in the form of vegetation. Dr. Kuiper's program included visual studies through a special filter transmitting only the ends of the visible spectrum, shorter than 5000 angstroms and longer than 6400. Terrestrial vegetation shows exaggerated fall coloration when viewed through such a filter. As the French astronomer A. Dollfus had had the same idea, he lent a similar filter to Dr. Kuiper for use at the large McDonald reflector. These experiments did not reveal any areas on Mars similar to terrestrial forests showing autumn colors.

The Yerkes astronomer remarked that, after the dust storms of 1956 had passed, the dark areas recovered well. Some years ago this phenomenon had suggested Martian vegetation to E. Opik; it seemed that the ability of a dark area to regenerate itself required the aid of living matter. Dr. Kuiper, however, suggested that this is not the only possible explanation. The Martian dark markings might be analogous to terrestrial lava fields, whose glassy surfaces can be swept free of dust by wind. On the other hand, the slight color variations of the dark markings do suggest some vegetation on the lava fields, he said.

GEORGE H. LUTZ DIES

An amateur telescope maker who spent many years experimenting with metal mirrors died in an automobile accident on January 20th. He was George H. Lutz, 82 years old, of Reseda, California, a native of Illinois. His mirror work with such substances as the extremely hard alloy, stellite, is described on pages 318 and 319 of *Amateur Telescope Making* (1950).

QUESTIONS... FROM THE S+T MAILBAG

Q. Where in the sky is the constellation Quadrans Muralis?

A. This constellation, now obsolete, was invented around the year 1800 by the German astronomer J. E. Bode, but was never generally accepted. Its only vestige is in the name of the Quadrantid meteor shower, which radiates from that part of the sky each January. The constellation covered the portion of Bootes next to the Big Dipper.

Q. I am a beginner about to obtain a small telescope. What kind of observing will give me the most pleasure?

A. The moon is particularly interesting, and maps of its surface features are readily available; it is the subject of many popular books. Star clusters, such as the Pleiades and the Beehive; easy double stars, such as Mizar in the handle of the Big Dipper; and the Great Nebula in Orion—all are especially attractive.

Q. Where can one obtain exact specifications of constellation boundaries?

A. Precise definitions of the modern boundaries of the constellations, as adopted by the International Astronomical Union, can be found in the appendix to the Yale Observatory *Catalogue of Bright Stars*, by L. Jenkins. These are the boundaries plotted in the Skalnate Pleso *Atlas of the Heavens* and in the latest edition of Norton's *Star Atlas*.

Q. Where can I obtain information about the nearest astronomy club?

A. Twice each year *Sky and Telescope* features Here and There with Amateurs, a guide to organized astronomy clubs for adults and juniors. The listing gives the name of the person to contact for further information. (See page 278 of this issue.)

Q. What is the presently accepted value for the velocity of light?

A. There is no one authoritative value. The figure 299,791 ± 1 kilometers per second is given by C. W. Allen in the book, *Astrophysical Quantities*, and should serve most purposes.

Q. What is the meaning of the designation LDS 275?

A. This is Luyten Double Star No. 275—one pair in the list of doubles found by W. J. Luyten, University of Minnesota, during his search for faint stars with large proper motions.

Q. I have trouble seeing the faintest naked-eye stars plotted in Norton's *Star Atlas*. How should I go about detecting them?

A. The central portion of the retina of the eye is much less sensitive to faint light than are its outer parts. Therefore, try using averted vision by looking at a point in the sky somewhat removed from where the star itself should be. Be sure your eye is dark-adapted, that you avoid looking at artificial lights, and that a red filter on your light source is used if charts or maps are being consulted while you are observing.

Q. What are the symbols that appear by some of the stars on the monthly star charts in *Sky and Telescope*?

A. These symbols are lower-case Greek letters which serve as star names, and were applied to the brightest stars in each constellation by Johannes Bayer in 1603. These letters are:

α	Alpha	ι	Iota	ρ	Rho
β	Beta	κ	Kappa	σ	Sigma
γ	Gamma	λ	Lambda	τ	Tau
δ	Delta	μ	Mu	υ	Upsilon
ε	Epsilon	ν	Nu	φ	Phi
ζ	Zeta	ξ	Xi	χ	Chi
η	Eta	ο	Omicron	ψ	Psi
θ	Theta	π	Pi	ω	Omega

Q. What can I use as a pointer in showing constellations to a class at night?

A. The beam of a 4- or 5-battery flashlight works well, particularly if the air is moist or dusty. The width of the beam should be adjustable.

W. E. S.

ASTRONOMICAL SCRAPBOOK

(Continued from page 265)

and saw the "planet" as a telescopic fixed star, with no indication of motion.

The sharpest criticism came from L. P. Thümmig, professor of philosophy at Halle. In his pamphlet, he said that he had observed the controversial object many times and that it was obviously an ordinary star. It was scarcely necessary, he added, for Professor Liebknecht to announce every telescopic star as new and to give it some special name. In reply, the angry Liebknecht wrote a 16-page rejoinder that heaped vulgar abuse on Thümmig, and the latter published a rebuttal that brought the squabble to a close.

There is a strange fact about this controversy to which Wilhelm Olbers called attention a century later. None of the disputants, not even Weidler with his 22-foot refractor, mention that Mizar is a visual double star. If they really did not see Mizar as double, it is hardly a tribute to the quality of the telescopes of that period.

In collecting this material on Mizar, thanks are due to Franklin Miller, Jr., of Kenyon College, Gambier, Ohio, for writing me about Mädler's observation. Full references to this are given in Nielsen's 1942 paper, in *Meddelelser* No. 16 of the Ole Römer Observatory. The facts on Sidus Ludoviciana are from the 1894 edition of Olbers' collected works, Volume 1, pages 523, 649, and 654.

JOSEPH ASHBROOK

NEWS NOTES

ANTIMATTER AND GRAVITATION

Physicists and astronomers have recently become interested in the possible existence of antimatter—material whose atoms have negatively charged nuclei surrounded by positive electrons, in contrast with ordinary atoms. If matter and antimatter were to collide, they would annihilate each other and release energy. But in cosmological speculations involving antimatter, it is necessary to know whether its gravitational interaction with ordinary matter would be an attraction or a repulsion.

An answer to this question has been given by D. C. Peaslee, a physicist at Purdue University, in the December 28, 1956, issue of *Science*. He presents a theoretical demonstration that the two kinds of matter will attract one another gravitationally, rather than repel. This rules out the possibility of a shield against the action of gravity. Electrical fields may be shielded because electrical charges of opposite sign can be separated, but there is no gravitational analogy to this separability.

Dr. Peaslee made his calculations for cases involving only weak gravitational fields and small relative velocities, so the distortion of space-time could be neglected and only static interactions had to be considered. Thus, the impossibility of gravity shields appears evident at least for all terrestrial applications.

PLANETARIUM IN LONDON

According to the English publication *Orb*, the world-famous wax museum, Madame Tussaud's on Marlybone Road, London, is erecting the first planetarium in Great Britain. It will seat some 550 persons under a 73-foot dome, and will house a Zeiss planetarium projector being made in West Germany. The London Planetarium, as it will be called, is scheduled to open late this year.

NEW VARIABLE STARS

The total number of stars in our galaxy that are officially recognized as variable has now reached 14,374, as the result of a new listing of 629 such objects in the *Eighth Supplement to the General Catalogue of Variable Stars*. This latest compilation was made by B. V. Kukarkin and his co-workers at the Sternberg Astronomical Institute, Moscow, who have been entrusted by the International Astronomical Union with the task of naming and cataloguing stars that change in brightness.

Most of the new discoveries are very faint objects detected on photographs, some being only of the 19th magnitude. Among the brightest stars on the new list is AI Draconis, an Algol-type variable that changes between visual magnitudes 7.0 and 8.1 in a period of 1.199 days. Its right ascension and declination for the epoch 1950 are $16^h\ 55^m.2$, $+52°\ 46'$. Three faint novae are included that appeared in the constellation Sagittarius in the years 1928, 1945, and 1955.

The constellation containing the largest number of recognized variables is Sagittarius, with 1,646. Next come Ophiuchus, 931; Aquila, 889; and Cygnus, 780.

SATELLITE EXPOSITION

The American Rocket Society is sponsoring a rocket and satellite exposition during its spring meeting at the Sheraton-Park Hotel, Washington, D. C., April 4-6. The exhibit will be located in the hotel's 14,000-square-foot exhibition hall. It is expected to include guided missiles, full-scale rocket and ramjet engines, a prototype of the artificial satellite, instrumentation and guidance equipment for missiles, telemetering apparatus, tracking systems, data reduction equipment, and many accessory and component items.

Subjects to be discussed during the society's eight technical sessions will include high-speed rocket test tracks, space sociology, and Project Vanguard. More than a thousand civilian and military specialists in missile and satellite work are expected to attend the meeting.

SOLAR ENERGY JOURNAL

A new quarterly, *Journal of Solar Energy Science and Engineering*, appeared in January, published by the Association for Applied Solar Energy, in Phoenix, Arizona. The magazine contains original papers and news of solar energy projects, as well as special departments.

The first issue includes articles on high-power solar installations; the available solar radiation in the United States for different seasons, latitudes, altitudes, and amounts of cloudiness; use of solar energy in small-scale industries; the mass culture of algae; and the details of a solar refrigeration apparatus.

Nonmembers may purchase single copies or subscriptions by writing the Association for Applied Solar Energy, 3424 N. Central Ave., Phoenix, Ariz.

CORNELL SUMMER INSTITUTE IN EARTH SCIENCES

Astronomy, geology, meteorology, and soil studies will be combined under the heading of earth science in an institute sponsored by the National Science Foundation at Cornell University, July 1st to August 10th. Although the institute is planned primarily for teachers of secondary-school science, the courses will be open to any qualified person for credit.

The astronomy division is under the direction of R. William Shaw, chairman of the department of astronomy at Cornell. The program will include two courses along the lines of the workshop in astronomy Dr. Shaw described in *Sky and Telescope*, March and May, 1956, pages 213 and 305, and there will be night sessions for work with telescopes.

Geology is under the direction of Victor Schmidt, with opportunities to study glaciation, collect paleontological specimens, and do other field work in the Finger Lakes region of New York State. With H. M. Johnson, the meteorological courses will place emphasis on weather observations and predictions. In the soil science program, under N. C. Brady, head of the department of agronomy, there will be visits to numerous field experiments in soil conservation.

In addition to the regular Cornell staff, at least two guest lecturers have been scheduled for each division. Further information may be obtained from Dr. Richard Fischer, director of the institute, Stone Hall, Cornell University, Ithaca, N. Y.

ELECTRONIC OPTICS SYMPOSIUM IN BOSTON

The New England section of the Optical Society of America and the Boston section of the Institute of Radio Engineers will conduct a symposium on image formation and measurement with electronic techniques, at the Boston Museum of Science on May 2nd. Included among the scheduled speakers is Dr. B. F. Burke, Carnegie Institution of Washington, who will talk on radio telescopes.

An exhibit of instruments will be held, featuring a miniature of the Harvard radio telescope, a model of satellite tracking equipment, and similar devices in fields allied to optics. The exhibit will be open to the public on the evening of May 1st. Further information may be secured from Frederick Brech, 26 Farwell St., Newtonville, Mass.

IN THE CURRENT JOURNALS

RADIO ASTRONOMY OF GALAXIES, by J. G. Bolton, *Publications* of the Astronomical Society of the Pacific, December, 1956. "Of normal external galaxies, the spirals appear to be the brightest in the radio spectrum; in fact no radio emission has yet been detected from normal S0 or elliptical galaxies. This may be due to the relatively low abundance of interstellar gas in these systems; however, present results are based on rather few galaxies, and future observations could easily change these conclusions."

ATOMIC CLOCKS, by Harold Lyons, *Scientific American*, February, 1957. "With precise control of the radio frequency it is possible to achieve accuracy to at least one part in 10 billion in the cesium clock. This would correspond to an error in timekeeping of one second in 300 years!"

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 96th meeting of the American Astronomical Society at New York City in December. Complete abstracts will appear in the Astronomical Journal.

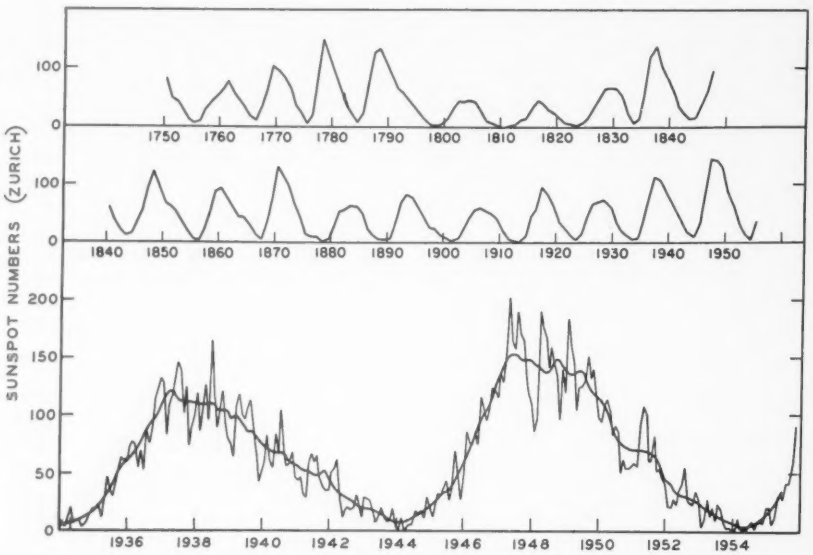
The Sunspot Cycle

"I often wonder whether those news writers who claim the most popular sports are bowling, fishing, basketball, or golf have ever looked up the statistics on the number of people who get their relaxation and exercise correlating sunspots with this and that."

These were the words of Dr. Seth B. Nicholson as he opened his address as retiring vice-president of Section D, American Association for the Advancement of Science. His subject was "The Solar Cycle." The Mount Wilson and Palomar astronomer pointed out that as early as 1801 Sir William Herschel had attempted to compare the number of sunspots and the price of wheat. It was known even then that sunspots were more numerous in some years than others, but not until about 40 years later did Heinrich Schwabe discover the sunspot cycle.

This German amateur had been recording the daily number of spots on the sun for two decades, and he was able to show that their frequency underwent a cyclic change. Just over 100 years ago, Rudolf Wolf, director of Zurich Observatory, began systematic daily observations of the sun, introducing an index number to denote the degree of solar spottedness. This index—the relative sunspot number—is still in use. Because of the many years during which the relative numbers have been continued, they have special value for statistical studies, although other index numbers have been introduced.

The length and amplitude of the solar cycle are themselves variable. Dr. Nicholson pointed out that for the past half a century the cycle length has been much

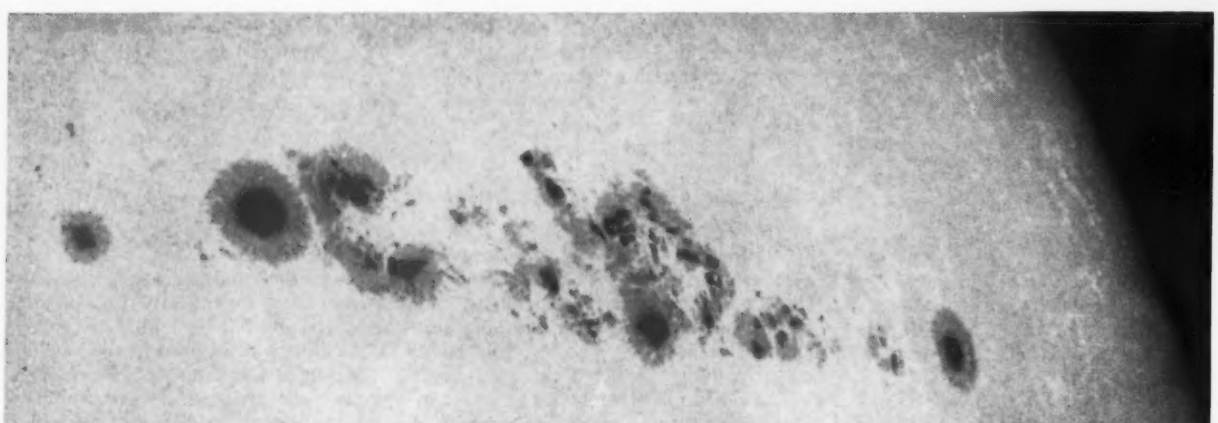


These curves picture the rise and fall of sunspot activity. The upper pair is plotted from yearly means of the smoothed monthly Zurich numbers since 1750, when fairly reliable data began. The jagged curve in the lower part represents monthly mean values for the two latest complete cycles; superimposed is the same curve smoothed. From the "Publications" of the Astronomical Society of the Pacific.

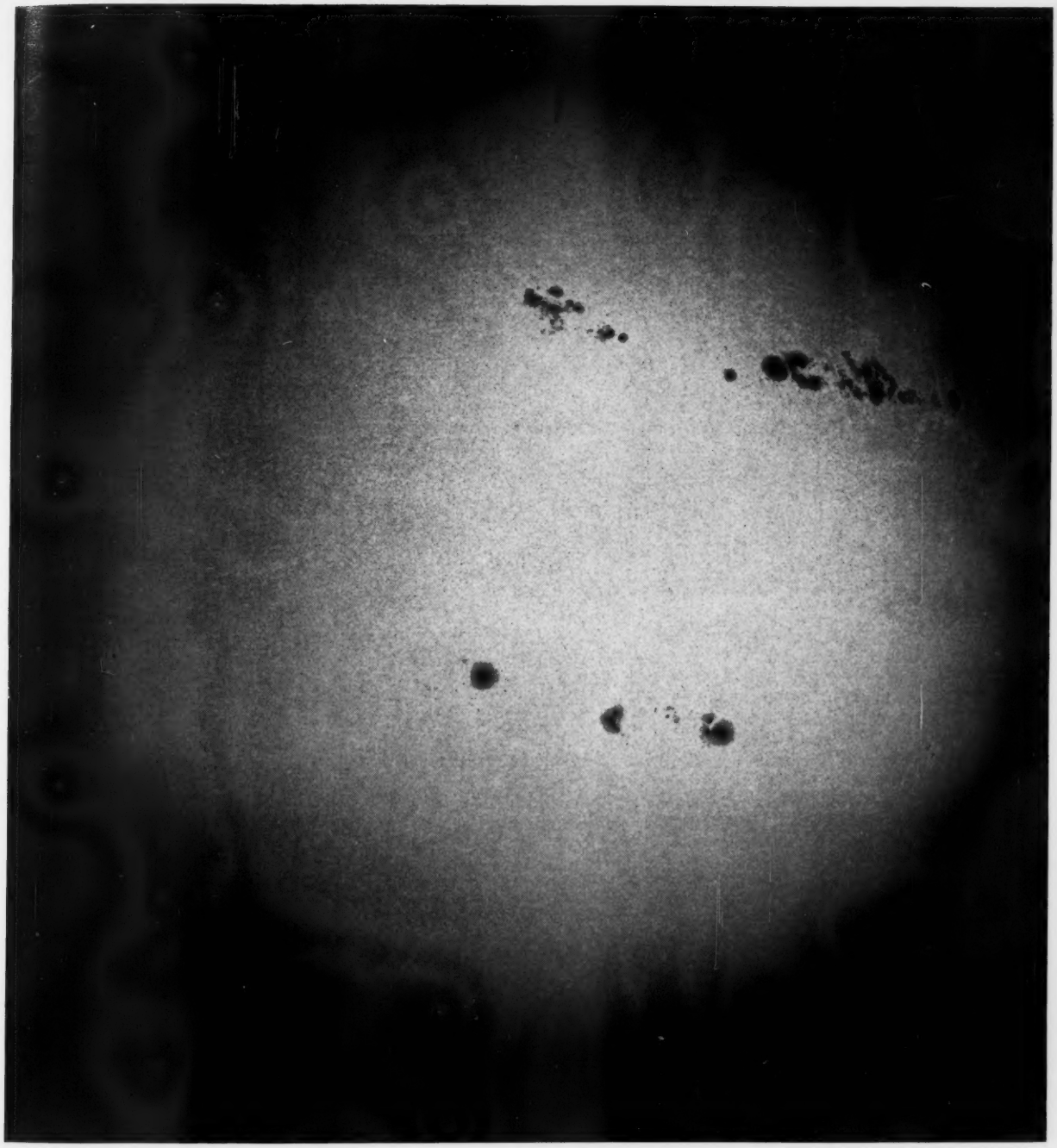
nearer 10 years than the over-all average of 11. Cycles with short periods tend definitely to have high activity; there is an even better correlation between the brevity of a cycle and the amplitude of the one that follows it. Another general property of the curve is that activity rises faster than it declines, particularly for high maxima.

At the present time, sunspots are unusually numerous, and at the last maximum, in 1947, solar activity was higher than ever recorded before. Because of uncertainties in standardizing old spot counts, we cannot be certain that the cycle of 1947 was higher than that of 1778, but it was clearly the highest in more than 100 years.

A striking feature of the record is that the five largest sunspot groups have all been observed since 1945. The largest until then was the group of February,



One of the streams of sunspots seen in the opposite picture of the whole sun on February 20, 1956, is enlarged here to show greater detail. The magnetic polarities of the spots indicated that this stream contained five separate sunspot groups. Mount Wilson and Palomar Observatories photograph.



The sun as photographed on February 20, 1956, at Mount Wilson Observatory, with west toward the right and north at the top. The spots are being carried toward the west limb by the sun's rotation. There are 14 sunspot groups in this picture; one stream of five groups in the northern hemisphere is shown enlarged on the facing page. The sunspot number for this day was very high: American 206, Zurich 260. Photograph courtesy Mount Wilson and Palomar Observatories.

1926, which covered an area of 4,300 million square miles. But the group of March and April, 1947, was nearly 50 per cent larger, with an area of 6,300 million square miles. On nearly half the days between January, 1946, and July, 1951, there were spots on the sun large enough to be seen without a telescope.

The low cycles included in the chart may not be the lowest of recent centuries. In the nine years from 1676 to 1684, no spots at all were observed on the sun; indeed, from 1676 to 1724 only about 25 spots were recorded. This shortage cannot have been due to the inferior telescopes then in use, as Herschel thought, for earlier observers—Galileo, Fabricius, and Scheiner—had observed many sunspots with even more primitive instruments. It is reasonable to believe that the five cycles prior to 1725 were actually much less active than any since.

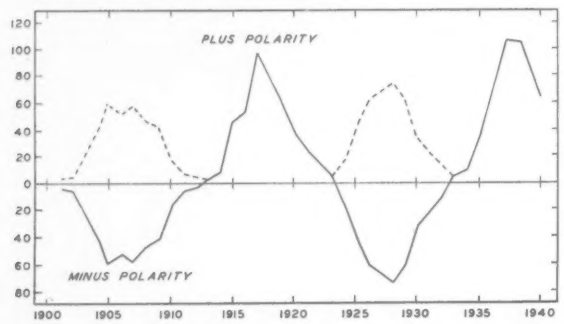
Dr. Nicholson cautioned those who try to correlate the solar cycle with weather changes or other terrestrial phenomena not to think of sunspots merely as numbers read and plotted from a table but rather as features on the sun that can be studied telescopically. For instance, a frequent mistake is to call the length of the cycle the interval from one maximum to the next, when it is definitely from minimum to minimum. This is shown by

the changing latitudes of sunspots as a cycle progresses and from the magnetic effect in sunspot spectra.

After minimum, the revival of spot activity occurs in two zones, 25 to 30 degrees north and south of the sun's equator. As the cycle proceeds, each zone slowly shifts equatorward, by about two degrees per year. At sunspot maximum, each zone has reached about latitude 15°, and by minimum activity the zones nearly touch the solar equator. Then, for almost a year, spots of the new cycle can be observed in high latitudes, while the last vestiges of the old cycle are still appearing close to the equator. Thus, the cycles overlap. Strictly speaking, each cycle, as counted from the first spots in high latitude to the last in low, is about a year longer than the time from minimum to minimum. The date assigned to minimum is very nearly that at which spots from the old and new cycles are equally numerous.

In the most recent cycle, the total number of groups was 3,420, exceeding any previous cycle by nearly 500, but the percentage in high latitudes was six times greater than in any other cycle during the nearly 80 years for which photographic records have been kept. In the 65 years from 1878 to 1943, only four spot groups were seen on more than one day in latitudes greater than 40°. This number was equaled in the first nine months of 1956. Perhaps activity in high latitudes is characteristic of very pronounced cycles; if so, the present maximum may break all records.

In 1908, G. E. Hale discovered that spectrum lines of sunspots show the Zeeman effect, the characteristic splitting of lines originating in a strong magnetic field. He found that spots at the opposite ends of a group had opposite magnetic polarities. At that time, bipolar groups in the northern hemisphere, unlike those of the present cycle, had spots with negative polarity in their western halves. But when the high-latitude spots of the next cycle appeared, the arrangement of their polarities was reversed. Five such reversals have now been observed.



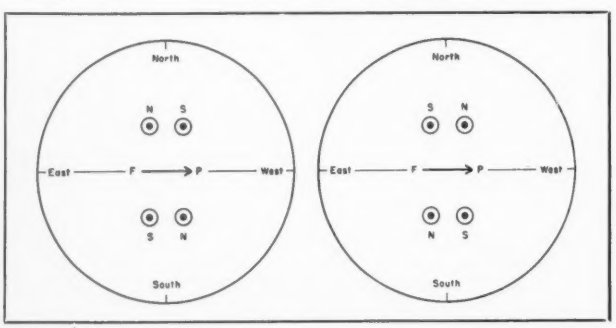
Dr. Nicholson has here plotted spot numbers as positive when the polarity of preceding spots in the northern hemisphere is north or plus. During this interval, sunspots were more numerous in "plus" than in "minus" cycles.

The behavior of the magnetic polarity in southern-hemisphere spot groups is just the opposite of that in the northern hemisphere of the sun, indicating that the fundamental cycle is 22 years instead of 11. But otherwise there seems to be very little difference between the two halves of the 22-year period. Dr. Nicholson therefore suggested that, if sunspots are an index of solar activity that affects weather on the earth, the 11-year cycle should show up in the weather records rather than a 22-year period.

Examination of the sunspot data shows that the amplitudes of 11-year cycles have been alternately high and low fairly consistently for the past century. From this, the 1947 maximum should have been a low one—instead it was the highest ever recorded. Perhaps, however, a "low" cycle is one that is lower than the mean of those on either side of it. To make the 1947 cycle a low one, the present maximum will have to be far higher; present indications are that this may happen.

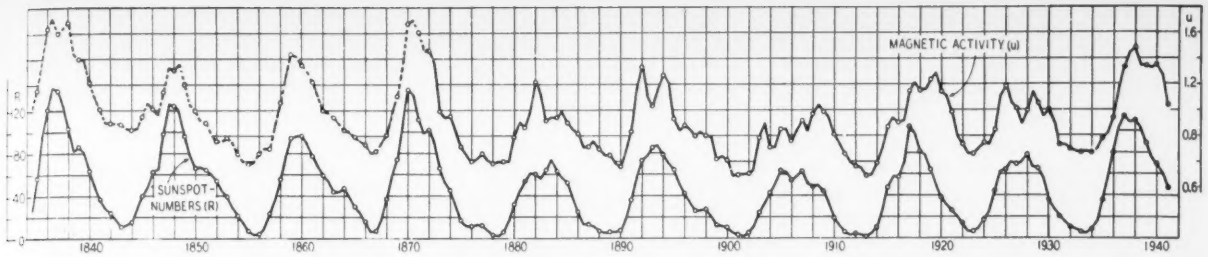
One complication in analysis of the solar cycle is sometimes overlooked. The number of spots does not vary smoothly, but there are waves or short-period fluctuations six to 13 months in length. The date selected as that of sunspot maximum often depends on which of three or four such secondary peaks is the highest, making it hard to predict just when a maximum will occur. Furthermore, at Zurich Observatory the maximum is established by taking 13-month running means of the sunspot numbers. This smooths out the fluctuations; but, as illustrated by the 1947 maximum, for several months the actual activity can be much higher than the adopted peak value of the smoothed curve.

For years it has been known that many (though not all) great sunspots are related to major disturbances of the earth's magnetic field. But if we select an index of geomagnetic activity that is not designed to favor great magnetic storms, such activity does not follow the sunspot curve very closely. A better correlation is that between sunspots and the amplitude of the diurnal variation of the earth's field on magnetically quiet days. Such variation depends on the amount of ionization in the earth's atmosphere caused by ultraviolet radiation from the sun. The degree of such ionization, measured in rocket and radio experiments, gives a better parallelism with sunspot numbers than does any other geophysical index num-



Above: The reversal of magnetic polarities in sunspots. The arrangement at the left represents the cycles of 1901-1913, 1923-1933, and 1944-1954; that at the right is for 1913-1923, 1933-1944, and the present cycle, with the leading spot of northern hemisphere groups having north or positive polarity.

Left: The sun on August 22, 1954, near minimum activity. On this date the American sunspot number was 19, Zurich 15. Mount Wilson and Palomar Observatories photograph.



A well-marked correlation between the magnetic activity of the earth and the occurrence of spots on the sun is evident in this diagram. The upper curve is of annual means of daily geomagnetic character numbers, which are plotted on the scale at the right: 0 for a magnetically quiet day, 1 for a moderately disturbed day, and 2 for a greatly disturbed one. Below these are plotted relative sunspot numbers (scale at left) for the same years, 1835-1941.

ber; it even mirrors the short-period fluctuations revealed by the sunspot counts.

In concluding his talk, Dr. Nicholson pointed out that, as we understand better the effects of sunspots and their radiations on the ionosphere and on the lower layers of the atmosphere, correlations between solar and terrestrial phenomena will become more definite.

Mars Drawings at Ottawa

To avoid preconceived ideas while observing Mars at its recent opposition, Peter M. Millman, National Research Council of Canada, did not study any detailed maps of the planet during 1956. Thus, his work at the 15-inch refractor of the Dominion Observatory, Ottawa, from August 17th to October 20th, was completely independent.

No Mars charts were taken to the telescope, and the central longitudes for the times of the individual drawings were not looked up in the ephemeris until some time after the observations had been made. The detail on Mars' disk was drawn by eye estimate alone, no micrometer being employed. Dr. Millman used a highly corrected 155x eyepiece. Higher powers, and orange and yellow filters, were tried repeatedly but did not improve the detail seen on the planet.

For a map of Mars as it appeared to Dr. Millman in 1956, Martian coordinates of the features observed were transferred from 68 drawings to a Mercator projection by a graphical method involving a globe and a projection disk. The final map shows the weighted mean positions of the features; it is being published in the March-April issue of the *Journal* of the Royal Astronomical Society of Canada.

Vegetation on Mars?

William M. Sinton, Harvard Observatory, pointed out that all terrestrial organic molecules show in their spectra a strong infrared absorption band at wave length 3.4 microns. This spectroscopic feature arises from the bond between carbon and hydrogen atoms. Accordingly, light from vegetation should have an absorption band close to this wave length, since the light penetrates beneath the surface before being reflected.

Dr. Sinton first verified the phenomenon for terrestrial plants, observing them with an infrared spectrometer. In fresh leaves, absorption bands of water tended to mask the expected feature, but relatively dry foliage showed a double absorption band centered on 3.45 microns and about 0.2 micron wide. In mosses and lichens the absorption of radiation was 20 to 30 per cent at this wave length, but the double band was only slightly separated.

After these control experiments, Dr. Sinton observed the infrared spectrum of Mars with the Harvard 61-inch reflector. As a detector he used a lead-sulfide cell, cooled in liquid nitrogen, which had good sensitivity to wave lengths as long as 3.6 microns. Since Mars is faint in this spectral region, it was necessary to combine many measurements made at each 0.1-micron interval of wave length in the vicinity of the carbon-hydrogen band.

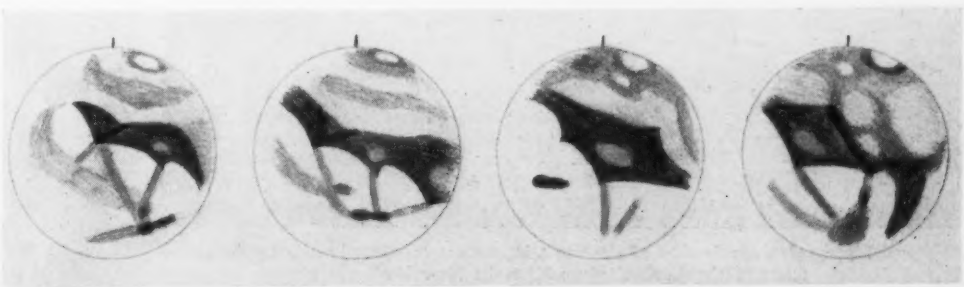
Such observations were carried out on four nights when all of the equipment was in good working order. The presence of the 3.45-micron absorption in Mars' spectrum is indicated by a statistical test that Dr. Sinton applied to his data. But so little Martian energy was available that it was not possible to measure bright and dark areas separately and intercompare them. This would have provided a more critical test than the observations of the planet as a whole. Nevertheless, he stated, "It seems highly probable that vegetation is present on Mars."

PLANETARY NEBULAE—II

(Continued from page 264)

the 200-inch, the other by Curtis was used by Gurzadian. It is evident that the 200-inch telescope shows far more complicated structure within planetaries than could have been inferred from the 36-inch Crossley observations alone. Minkowski and other astronomers are of the opinion that magnetic fields must play an important part in the development of a planetary. He believes there are indications that most of these nebulae have structural symmetry—for example, some have one or more narrow oval extensions, occasionally two or three at different orientations. But Gurzadian's discussion is still of great interest as a bold attempt to unravel the mystery of the planetary nebulae without invoking magnetic effects.

His work also reminds us that there is almost no contact between American and Russian astronomers. To my knowledge, hardly any American astronomer has visited Russia for research or teaching during this century. Also, there are only two or three isolated cases since 1914 of Russian astronomers visiting our country for research, the last being the late G. A. Shajn, with whom I worked at McDonald Observatory in 1947. Gurzadian's book is eloquent testimony to the need for an adequate international exchange of astronomical ideas.



Drawings of Mars by Peter M. Millman. The two at the left were made on August 25, 1956, at 6:10 and 7:20 UT; the others on August 18th at 5:00 and 6:50. The central meridian of Mars, left to right, was at longitude 177°, 194°, 223°, and 250° at these times.

Amateur Astronomers

Juniors Hold Symposium in New York City

THE BENEFIT of astronomy to young people was the theme of a symposium sponsored by the Astronomical League and Section D of the American Association for the Advancement of Science, in New York City last December 28th. Held in the large classroom in the basement of the American Museum-Hayden Planetarium, the session was attended by over 75 persons, many of them professional astronomers who had come to the joint meeting of the American Astronomical Society and Section D. Dr. Harold B. Davidson, a New York amateur astronomer, was chairman.

All but one of the amateurs participating in the program were teenagers; the other was 10-year-old Robert Strom, who talked on sunspot observing. His brother Stephen, a student at the High School of Science, has been studying astronomy for six years; he described his efforts at observing the planets. Saul Adelman, of Washington, D. C., whose father is editor of the *Junior Astronomer,* talked on building a telescope.

Five juniors from Louisville, Kentucky, comprised a panel discussing spectroscopy as a tool of astronomy. Participating were Carol Lipphard, a former Kentucky Junior Academy of Science award winner; Warren Smalley, vice-president of the Louisville Junior Astronomical Society; Marcellus Porter, a freshman at Massachusetts Institute of Technology and one of last year's winners of the Bausch and Lomb honorary science awards; John Cosgrove, a chemical engineering student at the University of Louisville and president of the Louisville junior club; and James Bullock, a physics major at the University of Chicago.

A way to apply the techniques of photomicrography to astrophotography was described by Martin Gersten, a student at New York's Stuyvesant High School. Two members of the Chicago Junior Astronomical Society, Bernadette Londak and Cecily Resnick, spoke on the theorem of equal areas and on double stars, respectively. They also extended an invitation to junior and teen-age astronomers everywhere to attend a convention at the Adler Planetarium in Chicago on April 8th.

A photographic exhibit of a radio telescope being built by George J. Nielson and Ivan E. Loftis, of the Columbus Astronomical Society in Ohio, was also scheduled. One of the first amateur radio telescopes, this instrument is pictured in the January-February issue of the Astronomical League *Bulletin*.

Completing the program were talks by Catharine Barry and Franklin Branley, of the Hayden Planetarium staff; Clarence Johnson, chairman of the Astronomical League's junior activities; and G. R. Wright, chairman of the national advisory committee for MOONWATCH.

Carol Lipphard gives the first of the five talks on spectroscopy by the Louisville team at the juniors' symposium in New York City.

SOUTHEAST REGION

The Southeast Region of the Astronomical League will hold its annual convention at Chapel Hill, North Carolina, May 4-5. The host will be the Chapel Hill Astronomy Club, which has scheduled a varied program at the Morehead Planetarium, as well as an exhibit.

Feature speakers will include Armand N. Spitz, co-ordinator of visual observations of artificial satellites, and Grace C. Scholz, president of the league. In addition to the annual banquet, there will be outdoor observing sessions.

Information concerning accommodations will be provided by Don E. Fowler, 228 Cobb Dormitory, University of North Carolina, Chapel Hill, N. C. Program time may be secured from Downey Funck, 256 N. E. 11th St., Delray Beach, Fla.

NORTHEAST CONVENTION

Dr. Dirk Brouwer, director of Yale University Observatory, will be the main speaker at the Northeast Region convention of the Astronomical League on Saturday, April 27th. The meeting will be held at the State Teachers College, New Haven, Conn., with the Astronomical Society of New Haven as host. Write Desmond Carney, Box 395, New Haven 2, Conn., chairman of the publicity committee, for further information.

ROCHESTER AMATEUR DIES

One of the leading amateur astronomers in Rochester, New York, Paul W. Stevens, died in January. He was a founder of the astronomy section of the Rochester Academy of Science, an active leader of co-operation between amateur groups in upper New York state, and a former chairman of the Northeast Region of the Astronomical League. He served as an optical engineer at the Hawk-Eye Works of the Eastman Kodak Co.

Mr. Stevens was well known to readers of *Sky and Telescope* for his numerous articles on eclipses and occultations. He took trips to observe eclipses, and encouraged unusual observations with binoculars and small telescopes, such as finding Venus on the same day in both the evening and morning skies.

THIS MONTH'S MEETINGS

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. April 12, Dr. Adriaan Blaauw, Yerkes Observatory, "Young Stars."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. April 29, John M. Hulme, "Limits of Space."

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. April 16, William Siekman, Jr., "Measuring the Universe."

Louisville, Ky.: Louisville Astronomical Society, 8:30 p.m., University of Louisville, Natural Science building. April 2, Louisville Junior Astronomical Society, "Double Stars and Variables."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. April 3, Dr. Peter van de Kamp, Sproul Observatory, "Stars and Their Companions."

Springfield, N. J.: Amateur Astronomical Society of Union County, 8 p.m., Regional High School. April 26, James S. Pickering, Hayden Planetarium, "The International Geophysical Year—1957-1958."

HELENA, MONTANA

Since the death of its founder Dr. Edward W. Neuman, the Carroll College Observatory, Helena, Montana, has had Dr. T. J. Mentrum as its temporary monitor. The building of this observatory was described in *Sky and Telescope* for July, 1946; its walls are made of red porphyry stone shaken loose from one of the college buildings by earthquakes in the fall of 1935.

It was also in that year that two students made the observatory's 12½-inch f/8 mirror, which is now being reconditioned. The observatory is regularly used for college instruction and for public open nights.

Dr. Mentrum is moderator of the Amateur Astronomy Club of Helena, which is comprised of junior high and high school students. Further information may be obtained from him at 504 Power Bldg., Helena, Mont.

AN OBSERVATORY IN IRAQ

My Mesopotamia Observatory is the only private one in Iraq. I have made all instruments for it, including a 6-inch reflector, 2-inch and 2.4-inch refractors. For an average of two hours each day I count sunspots, experiment in solar photography, and compare lunar formations with their appearances on old and new charts.

During the partial solar eclipse last December I took a series of pictures with my small camera telescope. I am now purchasing a 10-inch parabolic mirror to build a reflector for planetary observing.

I am a member of the British Astronomical Association and a fellow of the Royal Astronomical Society of England.

MICHAEL ABDUL AHAD
c/o Custom's House
Basrah, Iraq

Iraqi amateur astronomer M. A. Ahad and his 6-inch reflector.

The national advisory committee met with Col. Owen Clarke, Air Force liaison officer for MOONWATCH, and Paul H. Oehser (third from left) of the Smithsonian Institution. Photograph by Robert E. Cox.

National MOONWATCH Committee Meets at Smithsonian Observatory Headquarters

ON FEBRUARY 1-2, members of the national advisory committee for visual observers of artificial satellites visited the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, to discuss the MOONWATCH program. They held business sessions in the library of Harvard Observatory, and on Friday evening attended a banquet at a local hotel.

All phases of the financing, setting up, equipping, and manning of MOONWATCH stations were treated, under the guidance of Dr. Armand N. Spitz, Dr. J. Allen Hynek, Dr. Fred L. Whipple, and Leon Campbell, Jr., all of the Smithsonian staff. G. R. Wright, chairman of the committee, showed motion pictures in color of the prototype station at his home in Silver Spring, Maryland. A highlight of his presentation was a tape recording of a typical sound track of time signals and practice observations.

Those who attended are shown in the accompanying picture, from left to right: Edward A. Halbach, Milwaukee Astronomical Society; Grace C. Scholz, president, Astronomical League; Paul H. Oehser, chief, editorial and publications division, Smithsonian Institution; Mrs. Margaret W. Mayall, director, American Association of Variable Star Observers; Charles H. LeRoy, Amateur Astronomers Association of Pittsburgh; Thomas A. Cragg, Los Angeles Astronomical Society; Col. Owen Clarke, MOONWATCH liaison officer for the U. S. Air Force; Russell C. Maag, Central Missouri Amateur Astronomers; Bradford A. Smith, New Mexico College of Agriculture and Mechanic Arts; G. R. Wright, National Capital Astronomers; Walter H. Haas, director, Association of Lunar and Planetary Observers; Steadman Thompson, Columbus Astronomical Society; Walter Marion and Arthur S. Leonard, Eastbay Astronomical Society.

EDINA, MINNESOTA

The Edina Astronomy Club was organized last November 10th, at which time the following officers were elected: Dennis Lane, president; the undersigned, secretary; and Dr. John Korchick, treasurer. Since our first meeting, we have acquired an observatory, 14 feet in diameter, and plan to mount in it a 12-inch Newtonian reflector, which is being presented to us as a gift. We are in the process of obtaining a land grant from the village of Edina, a suburb of Minneapolis, for the observatory site.

Twenty-seven charter memberships have been issued covering 41 members in all. Our first class in telescope making is scheduled to begin in April.

FRED HAFNER
5608 Concord Ave.
Minneapolis 24, Minn.

MIDEAST CONVENTION

The Mideast Region of the Astronomical League will meet on June 8th at the Paxton Presbyterian Church, Harrisburg, Pa. Papers to be read at the convention should be sent to Cliff Raible, 200 Rebecca Square, Millvale, Pa. Exhibits will be received by Roy Brungard, 3228 Green St., Harrisburg, Pa.

HERE AND THERE WITH AMATEURS

The rapid growth of popular astronomy is reflected in this newly revised compilation of local amateur organizations in the United States, now listing 174 groups in 46 states and the District of Columbia. Only Mississippi and Maine are not represented.

Most of these societies hold regular meetings once or twice monthly, at which interested persons are always welcome. Details of each society's program can be obtained from the official whose name and address are given here.

*Members receive *Sky and Telescope* as a privilege of membership.
†Member organizations of the Astronomical League.
‡Member organizations of the Western Amateur Astronomers.
°Society has junior section.
☆Independent junior society.

ALABAMA

BIRMINGHAM
Shades Valley Astronomy Club *
Mrs. I. M. Cox, 208 Dexter Ave. (9). TR 1-1639

HUNTSVILLE
Rocket City Astronomical Ass'n. †
B. S. Isbell, 509 Bluefield Ave. JE 2-8253

ARIZONA

PHOENIX
Phoenix Observatory Ass'n. *‡
A. H. Hoff, Phoenix Coll. AM 6-4441

TUCSON
Tucson Amateur Astronomers *
E. C. Burch, 216 Busch Pl. AX 8-1394

ARKANSAS

AUGUSTA
Augusta Astronomy Club †☆
J. W. Haralson, Box 634. Augusta 35

LITTLE ROCK
Arkansas Amateur Astronomy Club †
J. Adams, 2216 State St. FR 2-6801

CALIFORNIA

BAKERSFIELD
Kern Astronomical Society, Inc. †
B. Buchholz, 2609 Charleston Dr. EX 9-3186

LONG BEACH
Excelsior Telescope Club *†‡
T. R. Cave, Jr., 265 Roswell Ave. HE 4-2263

LOS ANGELES
Los Angeles Astronomical Society, Inc. ‡
Miss H. Pearce, 1000 N. Seward St. (38). HO 9-6321

OAKLAND
Eastbay Astronomical Society, Inc. *‡
F. O. Groch, 2315 Eunice St., Berkeley. LA 4-4463

OROVILLE
Feather River Astronomy Club
J. T. Jensen, Rte. 4, Box 1732. LE 3-0471

PALO ALTO
Peninsula Astronomical Society *‡
Miss A. Alksne, 4115 Amaranta Ave. DA 2-4406

REDLANDS
Redlands Astronomical Society *
Mrs. E. Patterson, 2698 Fremontia Dr., San Bernardino. 83-7238

SACRAMENTO
Sacramento Valley Astronomical Society *‡
Mrs. H. N. Smith, 1608 48th St. (19). GL 1-1483

SAN FRANCISCO
San Francisco Amateur Astronomers *‡
H. Sturiale, Apt. 21, 1349 Clayton St. UN 3-3808

SAN JOSE
San Jose Amateur Astronomers *‡
W. W. Phelps, 21090 Hazelbrook Dr., Cupertino. CH 3-1649

SAN RAFAEL
Marin Amateur Astronomers *‡
Mrs. I. D. Osborn, 411 Vendola Dr. GL 4-2769

SANTA ANA
Orange County Amateur Astronomers *
G. H. Shaw, 2061 Halladay St. KI 3-9131

SANTA BARBARA
Santa Barbara Star Cluster ‡
Capt. C. Adair, 607 Miramonte Dr. 2-1717

STOCKTON
Stockton Astronomical Society *‡
J. E. Gabrian, 1917 Bristol St. HO 3-6629

WHITTIER
Whittier Amateur Astronomers Ass'n. *‡
G. E. Hughes, Box 531. OX 4-2840

COLORADO

BOULDER
Boulder Astronomical Society *†
V. A. Ryan, 1629 North St. HI 2-6223

DENVER
Denver Astronomical Society †°
E. H. Bronstein, 1747 S. Jasmine (22). SK 6-3232

PUEBLO
Pueblo Astronomical Society *†‡
Mrs. M. Struthers, 2329 E. Routt Ave. LI 3-1833
Pueblo Junior Astronomical Society †☆
H. Niethammer, 839 Van Buren. LI 4-2819

CONNECTICUT

MIDDLETOWN
Central Connecticut Amateur Astronomers *†
W. Fellows, R.F.D. 1, Hebron Ave., Glastonbury. ME 3-1871

NEW HAVEN
New Haven Astronomical Society, Inc. †
Mrs. J. Plato, 427 Ridgeview Rd., Orange. SY 9-2524

NEW LONDON
Thames Amateur Astronomical Society *
R. T. Steinhilber, R.F.D. 2, Goshen Rd., Waterford. GI 2-1376

STRATFORD
Boothe Memorial Astronomical Society, Inc. *†
B. W. Reilly, Box 2272, Noble Sta., Bridgeport (8). ED 6-9287

DELAWARE

NEWARK
Delaware Astronomical Society *†
R. J. Van Caneghem, 11 Kullen Dr., Brookside. EN 8-6024

DISTRICT OF COLUMBIA

WASHINGTON
National Capital Astronomers *†°
Miss E. Dimick, 1305 N. Longfellow St., Arlington, Va. KE 8-5619

FLORIDA

DAYTONA BEACH
Daytona Beach Star Gazers
W. T. Thomas, 105 N. Halifax. CL 2-8049

EAU GALLIE
Indian River Astronomical Society †
Mrs. H. M. De Paolo, 1353 Everglade Dr. 3213

FT. LAUDERDALE
Ft. Lauderdale Astronomical Society †
Dr. F. Denniston, 915 N. E. 2nd St. JA 2-5224

JACKSONVILLE
Jacksonville Amateur Astronomers Club *†°
E. L. Rowland, Jr., 225 W. Ashley St. EL 4-8597

KEY WEST
Key West Astronomy Club *†
Miss M. W. Turner, 95 Sigsbee Rd., Box 915. 6-9803

MIAMI
Gulfstream Astronomical Ass'n., Inc. *†
H. A. Thompson, 1118 Alberca, Coral Gables. HI 8-2873
Southern Cross Astronomical Society, Inc. *†
A. P. Smith, Jr., 1601 S.W. 10th St. FR 4-7145

ORLANDO
Amateur Astronomy Club of Orlando *
Mrs. R. Lee, 445 Rock Lake Dr. 5-9000

ST. PETERSBURG
St. Petersburg Amateur Astronomy Club †
Mrs. J. D. Rains, 2830 10th Ave. N. 79-9854

WEST PALM BEACH
Astronomers Club of the Palm Beaches †
Mrs. D. D. Sinclair, Box 1108. JU 2-6830

GEORGIA

ATLANTA
Atlanta Astronomy Club *†°
W. H. Close, 225 Forkner Dr., Decatur. DR 3-3945

MACON
Macon Amateur Astronomers Club *†
P. E. Haines, 505 Eldorado Dr. 5-5084

IDAHO

IDAHO FALLS
Idaho Falls Astronomical Society
Mrs. O. D. Hendrickson, 475 J St. JA 2-3474

ILLINOIS

CHICAGO
Chicago Astronomical Society *†
J. A. Anderer, 7850 S. Ada St.
Chicago Junior Astronomical Society †☆
E. Zimmermann, 133 Franklin Ave., River Forest. FO 9-8186

GALESBURG
Galesburg Amateur Astronomers *†
H. L. Horein, 1246 N. Morton Ave. 7337-2

GENEVA
Fox Valley Astronomical Society *
J. Zoda, 420 Fellows St., St. Charles. 5507

LEMONT
Argonne Astronomy Club *
H. DaBoll, Box 299, Argonne Nat'l. Lab. 800, ext. 2711

LOMBARD
Tree Towns Astronomy Club †☆
L. Ewing, 26 S. Westmore Ave. 4153-J

MOLINE
Popular Astronomy Club *†
C. H. Gamble, 3201 Coaltown Rd. 4-2035

OAK PARK
Sirius Astronomical Society †☆
Miss C. Resnick, 722 N. Lombard Ave. EU 6-4742

PEORIA
Astronomy Section, Academy of Science
R. P. Van Zandt, 1100 N. Parkside Dr. 4-5621

INDIANA

EVANSVILLE
Evansville Astronomical Society †
Dr. R. T. Dufford, 512 S. Weinbach Ave. (14). GR 6-7856

INDIANAPOLIS
Indiana Astronomical Society *†°
W. E. Wilkins, 6124 Dewey Ave. FL 7-5946

KOKOMO
Kokomo Amateur Astronomical Society *
C. C. Luttrell, 1339 S. Ohio Ave. GL 9-9587

IOWA

DES MOINES
Des Moines Div., Great Plains Astronomical Soc.
D. P. Cruikshank, 3655 67th St. (10). CR 7-5852

WATERLOO
Northeast Iowa Div., Great Plains Ast. Soc. *†
C. P. Martens, Rte. 4, Charles City. 2152-M

KANSAS

TOPEKA
Topeka Astronomical Society
D. Helm, 224 Buchanan St. 3-9307

WICHITA
Wichita Astronomical Society *†
S. S. Whitehead, 425 N. Lorraine (8). MU 2-6642

KENTUCKY

LOUISVILLE
Louisville Astronomical Society †
Mrs. V. C. Lipphard, 2421 Calvin (6). TW 6-9084
Louisville Junior Astronomical Society *†☆
D. Kleinman, 1414 Goddard (4). HI 1365-J

LOUISIANA

GRETNA
Gretna Astronomical Society
J. A. Gunther, 209 Newton St. FO 1-0034

NEW ORLEANS
New Orleans Amateur Astronomers Ass'n.
W. E. Wulf, 2107 Annunciation St. (13). RA 0706

MARYLAND

BALTIMORE
Baltimore Astronomical Society
Mrs. L. Finglass, 3813 Glen Ave. (15). FO 7-0385

MASSACHUSETTS

CAMBRIDGE
Bond Astronomical Club *†
R. C. Smith, 519 Morrissey Blvd., N. Quincy (71). GR 2-1938
Amateur Telescope Makers of Boston *†
R. E. Cox, 32 Shepard St. (38). EL 4-3536

SPRINGFIELD
Springfield Stars Club *†°
J. E. Welch, 107 Lower Beverly Hills, W. Springfield. RE 4-9179

WORCESTER
Aldrich Astronomical Society *†
O. Nelson, 115 Barret Ave. PL 4-1348

MICHIGAN

BATTLE CREEK
Battle Creek Amateur Astronomy Club †
Mrs. W. V. Eichenlaub, 47 Everett Ave. 2-3059

DETROIT
Detroit Astronomical Society, Inc. *†
T. W. Sulisz, 3310 Dartmouth (17). WA 8-8949

GRAND RAPIDS
Grand Rapids Amateur Astronomical Ass'n. *
J. C. Veen, Sr., 2100 Francis Ave. S.E. (7). CH 3-3098

JACKSON
Jackson Astronomical Society
W. H. Ketts, Jr., 2901 Robinson Rd. ST 2-9731

KALAMAZOO
Kalamazoo Amateur Astronomical Ass'n. †
Mrs. V. Shellman, 3809 Allendale. FI 4-8295

LANSING
Lansing Amateur Astronomy Club *†
R. C. Elliott, 434 Cowley Ave., E. Lansing. ED 2-5241

PONTIAC
Pontiac-Northwest Detroit Astronomers Ass'n. *†
G. Carhart, 40 Hadsell Dr. FE 2-9980

MINNESOTA

EDINA
Edina Astronomy Club *
D. Lane, 4006 W. 44th St.

MINNEAPOLIS
Minneapolis Astronomy Club †
Mrs. M. B. Haarstick, Science Mus., Pub. Libr. FE 8-0781
Minneapolis Junior Astronomy Club *†☆
Mrs. M. B. Haarstick, Science Mus., Pub. Libr. FE 8-0781

ST. PAUL
St. Paul Telescope Club *†
F. F. Miller, 1212 7th Ave. S., S. St. Paul. GL 5-5934

MISSOURI

FAYETTE
Central Missouri Amateur Astronomers *†
R. C. Maag, 904 S. Ohio St., Sedalia. 206

KANSAS CITY
Astronomy Club of Kansas City *†
Mrs. L. Kinsey, 1522 Brush Creek. WA 3-3410

ST. LOUIS
St. Louis Astronomical Society *†
Mrs. N. Fallert, 9804 Honeycut Lane (19). WO 1-8427

MONTANA

HELENA
Amateur Astronomy Club of Helena ☆
Dr. T. J. Mentrum, 504 Power Bldg. HI 2-0293

NEBRASKA

OMAHA
Omaha Div., Great Plains Astronomical Soc.
R. Osborn, 2035 N. 53 St. GL 5431

NEVADA

RENO
Astronomical Society of Nevada ‡
A. A. Garroway, 2040 Meadow View Lane. FA 3-0696

NEW HAMPSHIRE

NEWMARKET
Great Bay Amateur Astronomers *
A. R. Brackett, 9 Page St., Kittery, Me. ID 9-9439

NEW JERSEY

CALDWELL
West Essex Astronomical Society
R. M. Greenley, 412 Bloomfield Ave. CA 6-6751

ROSELLE PARK
Amateur Astronomers of Union County *†
W. A. Munn, 220 E. Westfield Ave. CH 5-2949

RUTHERFORD
Astronomical Society of Rutherford
Mrs. A. E. Cox, 478 Riverside Terr. WE 9-0453

TEANECK
Bergen County Astronomical Society †
Miss E. Goldenberg, 628 S. Forest Dr., W. Englewood. TE 6-1534

NEW MEXICO

LAS CRUCES
Astronomical Society of Las Cruces *†‡°
J. E. Durrenberger, Box 625. JA 6-2968

ROSWELL
Pecos Valley Sky and Telescope Club *
Dr. R. R. Boice, Rte. 2, Box 163-A. MA 2-7171

NEW YORK

ALBANY
Albany Astronomical Ass'n. *†
A. L. Swider, 42 Hanes St. (3). 8-3784

BABYLON
Long Island Observers' Ass'n. *
J. A. Tosto, 8 Bacon Lane. MO 9-9173

BINGHAMTON
Astronomical Society of Broome County
Dr. S. D. Molyneaux, Jr., 22 Murray St. 4-4620

BROOKLYN
Junior Astronomy Club †☆
M. L. Gersten, 555 Crown St. (13). IN 7-1854

BUFFALO
Buffalo Astronomical Ass'n. *†
G. N. Rote, 82 Floradale Ave., Tonawanda. AM 8150

CORNING
Corning Astronomy Club °
Mrs. F. English, Jr., 493 N. Hamilton St., Painted Post. 6-4414

JAMESTOWN
Astronomers Guild of Jamestown *
B. Hanson, 613 Stowe St. 92-811

NEW YORK
Amateur Astronomers Ass'n., Inc. *
G. V. Plachy, 201 W. 79th St., Room 1010 (24). EN 2-7100

ROCHESTER
Astronomy Section, Academy of Science †
Miss J. M. Brown, 460 Campbell St. (11). GE 8-7284-M

SCHENECTADY
Schenectady Astronomy Club *†°
C. E. Johnson, 102 State St. DI 6-9522

SYRACUSE
Syracuse Astronomical Society †
C. D. Fuller, 130 Falls Blvd., Chittenango. 6881

TROY
Rensselaer Astrophysical Society *†
Dr. R. Fleischer, Rensselaer Polytechnic Inst. AS 2-4678
Troy Astronomy Club †
J. T. Watkins, Valley Falls. PL 3-4195

UTICA
Utica Amateur Astronomers *†
R. L. Carner, 2 Ridge Pl. 4-0874

WANTAGH
Long Island Astronomical Society
A. R. Luechinger, 2009 Seaford Ave. SU 5-1571

NORTH CAROLINA

CHAPEL HILL
Chapel Hill Astronomy Club *†
Miss M. I. Perry, 9 Maxwell Rd. 9-6334

CHARLOTTE
Charlotte Amateur Astronomers Club *†
F. Selby, 200 S. Laurel Ave. (7). ED 3-3933

GREENSBORO
Greensboro Astronomy Club *†
Dr. A. D. Shaftesbury, 315 Tate St. 2-6528

WINSTON-SALEM
Forsyth Astronomical Society *†
K. A. Shepherd, 903 West End Blvd. 2-1631

NORTH DAKOTA

GRAND FORKS
Red River Astronomy Club *
L. B. Speare, 1925 Viets Ave. 4-4705

OHIO

AKRON
Astronomy Club of Akron *
Mrs. R. J. Couts, 878 Kennebec Ave. (5). ST 4-8450

BAY VILLAGE
Lake Erie Jr. Museum Junior Astronomers †☆
Mrs. E. W. Fleming, 630 Canterbury Rd. TR 1-3742

CINCINNATI
Cincinnati Astronomical Ass'n. *
J. T. Mettey, 2914 Minot Ave. (9). ME 1-0755
Cincinnati Astronomical Society, Inc. *
Mrs. D. H. Watson, 1832 Waltham Ave. (24). WE 1-5919

CLEVELAND
Cleveland Astronomical Society
Warner and Swasey Obs., Taylor Rd., E. Cleveland (12). GL 1-5625

COLUMBUS
Battelle Astronomy Club *
J. W. Kissel, Battelle Mem. Inst., 505 King Ave. AX 9-3191, ext. 363-2330
Columbus Astronomical Society *†
Mrs. J. Gann, 420 N. Cassady Rd. (9). CL 2-8421

DAYTON
Miami Valley Astronomical Society *
F. E. Sutter, 5038 Dayton-Lebanon Pike (9). WA 1827

ELYRIA
Black River Astronomical Society *
G. Diedrich, 653 Weller Rd. 44-033

LIMA
Lima Astronomy Club *
Mrs. R. E. Kampf, 478 N. West St. 4-8391

MARIETTA
Marietta Astronomical Society °
Miss L. E. Cisler, Cisler Terr. FR 3-0231

NEWARK
Newark Astronomical Society
G. Cooperrider, 326 N. 11th St. FA 3-0452

TOLEDO
Toledo Astronomical Society
E. D. Edenburn, 4124 Commonwealth Ave. (12). CH 3-3558

WARREN
Mahoning Valley Astronomical Society
Mrs. C. R. Prather, 1363 Drexel Ave. N. W. 4494-2

YOUNGSTOWN
Youngstown Astronomy Club *
A. Luszcz, 141 E. Delason Ave. RI 4-3836

OKLAHOMA

TULSA
Astronomy Club of Tulsa *†
R. F. Reid, 1948 E. 14th St. WE 9-5286

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THE TRANSIT OF MERCURY IN MAY

ABOUT 13 times each century the planet Mercury passes in front of the sun. If skies are clear on Sunday afternoon, May 5th, over the central and western parts of the United States and Canada, amateur astronomers will be able to watch such a transit. This unusual event last took place on November 14, 1953, and will not recur until the year 1960.

The planet will not be easy to detect in silhouette against the sun, for it will be 52 million miles away and is only 3,100 miles in diameter. Its angular size will be 12 seconds of arc, as large as a 50-cent piece would look a third of a mile away. A 3-inch refractor or a 6-inch reflector, with a magnification of 50x to 100x, will be adequate to observe the transit, but smaller instruments may serve.

To avoid permanent damage to the eye or blindness from the dazzling sun, project the solar image upon a white cardboard or screen held a foot or more behind the eyepiece. This procedure is safe, and has the important advantage of allowing several persons to observe simultaneously with the same telescope. Other safe methods of viewing the sun are outlined in observing manuals; one is to reduce the aperture to two inches or less with a diaphragm over the objective, using a Herschel wedge to dissipate most of the solar radiation. Dark eyepiece filters should never be used alone, as they may crack under the intense heat near the focus of the telescope (see *Sky and Telescope,* October, 1956, page 567).

In a transit of Mercury, there are four contacts that correspond to those of an annular eclipse of the sun. The first, contact I, occurs when the planet is externally tangent to the limb of the sun; at II all of Mercury is seen against the solar disk; at III the planet reaches the other limb; and at IV it has just passed completely off. The following predictions from the *American Ephemeris* are geocentric, that is, they suppose an observer to be at the center of the earth (or he may have the sun in his zenith):

I	May 5	23^h	59^m	$05^s.8$	UT
II	May 6	0^h	09^m	$00^s.3$	
III	May 6	2^h	19^m	$24^s.9$	
IV	May 6	2^h	29^m	$19^s.5$	

As United States observers will have the sun to the west of the meridian, contact times will come earlier by up to three minutes. The following schedule will hold within a minute or two for all places in the continental United States; all times are p.m. on May 5th (add one hour for daylight saving time):

	EST	CST	MST	PST
I	6:56	5:56	4:56	3:56
II	7:06	6:06	5:06	4:06
III	9:19	8:19	7:19	6:19
IV	9:29	8:29	7:29	6:29

The accompanying map will enable observers to decide whether or not the transit can be seen at their respective locations. Along the line *A* Mercury will just be setting as it first touches the sun, and along line *B* the planet will be 10 degrees above the horizon for this contact. Observers on or east of *A* will see nothing of the transit; between *A* and *B* they may glimpse its beginning phases, if their western horizon is unobstructed, but in general satisfactory observations may not be possible. West of line *B* the transit will be higher in the sky and viewed to better advantage.

In the central part of the country, the beginning of the transit will be visible, but the sun will set with Mercury still upon its disk. Only along the West Coast will the entire transit be observable. The *Ephemeris* lists third and fourth contact times for stations in California, Idaho, Montana, Nevada, Oregon, Utah, and Washington; also for Alaska, Hawaii, and Samoa.

As the chart shows, this transit of Mercury is nearly a grazing one, with the planet passing well to the north of the sun's center. As watched in the western sky with an inverting telescope, Mercury will enter a little below the left-hand extremity of the sun's disk, and its apparent motion will be upward. This very oblique entry of Mercury results in the unusually long interval of 10 minutes between external tangency and internal tangency of the two disks, and similarly at egress. At the previous transit, in 1953, only about 3½ minutes separated contacts I and II.

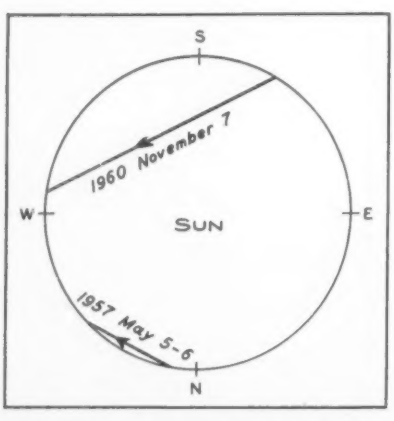
The coming transit may therefore provide an exceptionally good view of the so-called black drop. This is an appearance often (but not invariably) noted when Mercury has entered partially upon the sun—for a short interval the planet seems to hang like a black drop of ink adhering to the sun's edge. The ligament stretches and finally breaks.

The gradualness of the contacts themselves will make them difficult to time, and such observations will be less useful than at other recent transits. For this reason, there is no organized program to secure large numbers of such timings as in 1953. However, observers who do secure reliable observations are requested to report them in detail to this magazine.

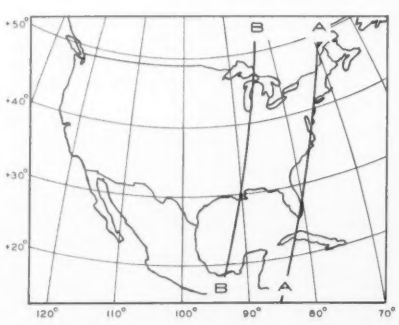
The two stages of the transit for which timing is most desirable are contact II, which is the moment of rupture of the black drop, or when light can first be seen all around the planet; and contact III, which is the moment at egress when the black drop forms, or when the thread of light between Mercury and the solar limb is broken. Such timings should be recorded to the nearest second, with a timepiece whose correction is known from WWV time signals or their equivalent. Detailed directions for observations of this type are given in *Sky and Telescope,* October, 1953, page 312 (out of print).

It is a wise precaution for an observer to point his telescope at the sun a day or two before the transit, at the same hour and minute that the phenomenon is to begin. This is an easy way to find out if the late afternoon sun will be blocked by trees or other obstructions, making selection of another observing site necessary.

Photography of the transit will provide a permanent record, but the disk of Mercury is only 1/160 the diameter of the sun, and a long-focus camera is required, to produce as large an image as possible. The telescope can be used as a camera, with the eyepiece serving as a projection lens. The sunspots that are now so numerous furnish excellent objects on which to focus for test exposures in advance of the transit.



The paths of Mercury across the sun at the next two transits.



East of line A the transit will be wholly unobservable; west of B good views will be possible.

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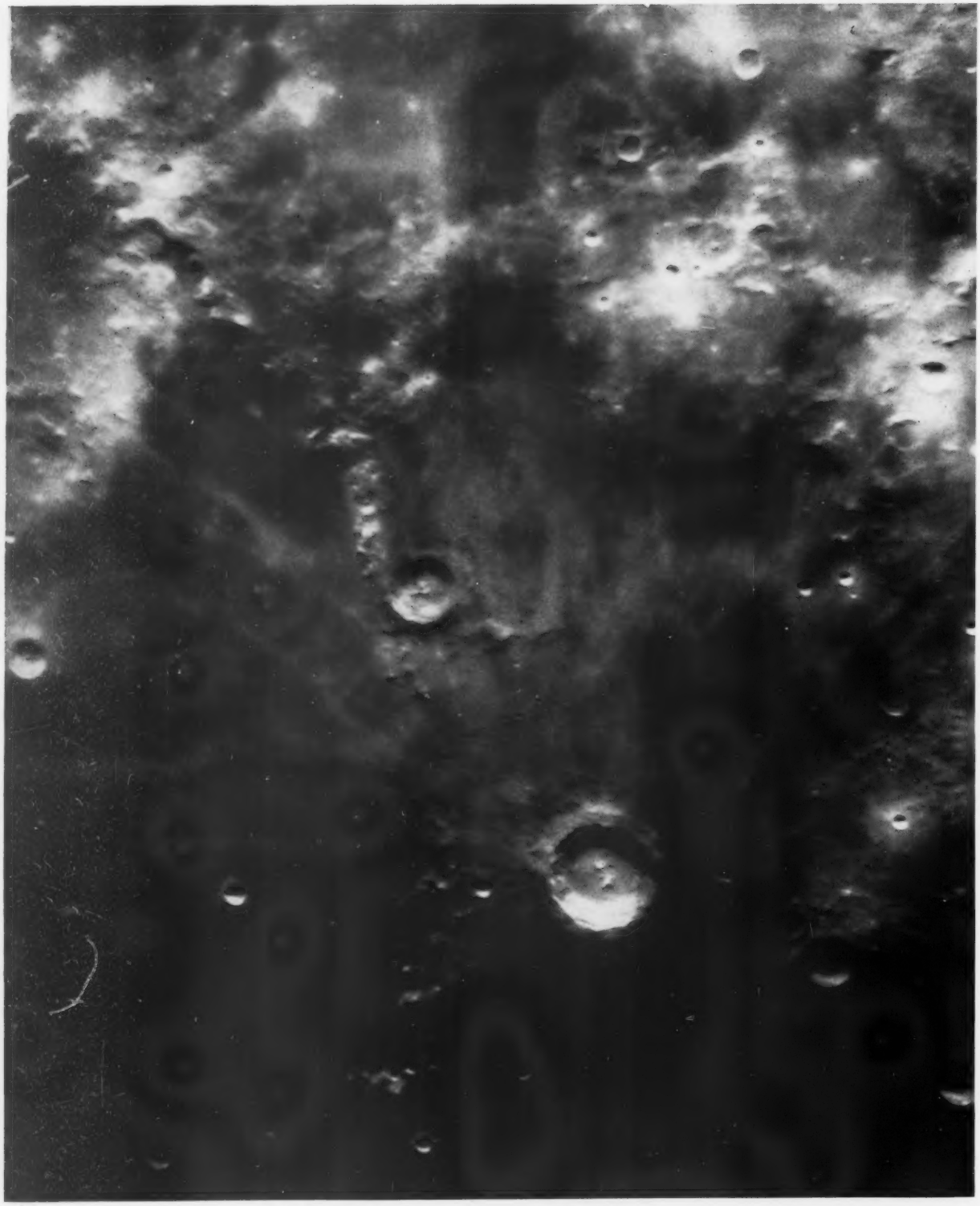

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This is the second of a series by Mr. and Mrs. R. Davis of Florida, and was taken at sea level the night of February 9, 1957. For proper viewing, the left margin should become the bottom. On this scale the whole moon would measure nearly 30 inches; and the region shown surrounds the crater Copernicus. A wealth of tiny craterlets and crisp detail is on the print, but no film grain at all is evident.

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BOOKS AND THE SKY

THE CHANGING UNIVERSE

John Pfeiffer. Random House, New York, 1956. 243 pages. $4.75.

IN THE LAST 25 years, astronomy has reached a wide public through a number of popular books of high standard and fluent style. The radio branch of the subject, however, is so young and has been developing so rapidly that few outsiders have been able to obtain an over-all perspective of it. Two textbooks have recently appeared on radio astronomy, and now we have a popular account for which a large sale can be predicted.

John Pfeiffer is a professional science writer with a wide experience in presenting science to the public. This book was written with the aid of a fellowship granted by the Guggenheim foundation, through which he was able to visit the main radio observatories in the United States, England, and Holland (but not, unfortunately, Australia). He has thus acquired a wealth of information from discussions and correspondence with many radio astronomers, and has welded it into a well-organized and very readable review of the whole subject.

The book begins with an extended account of the first discovery of "cosmic static" in 1932 by Karl Jansky and a description of the pioneer work of Grote Reber. Then the radio method of observing the sky is explained, as well as the various techniques that have been used, and their capabilities and limitations. The main part of the book covers the various branches of radio astronomy in turn—studies of the sun, radio sources, the galaxy, interstellar gas, and radar echoes from meteors and the moon. There is a stimulating final chapter on "The Future."

Mr. Pfeiffer writes with an easy, flowing style, and enlivens his story with many personal anecdotes, striking analogies, and imagery. "As you read the previous sentence, the sun consumed and lost twelve million tons of its gases." His treatment of the resolving power of a radio antenna and the operation of an interferometer system—subjects always difficult to get across to a nontechnical audience—is particularly good. There is an interesting collection of photographs and some novel drawings, but cross references between text and illustrations would have helped the continuity.

The author displays a striking grasp of the entire subject, including the relation of recent radio work to the general body of astronomical knowledge, and the objectives of future research. Because of this, the book gives probably the best review available at present of the status of radio astronomy.

Although the over-all treatment is good, the factual accuracy is not up to the standard set by earlier books in popular astronomy written by such authorities as Jeans, Eddington, and Hoyle. The discussion is rather confused in some places, and there are a few errors of fact—some scientific, some historical.

So impressed by the successes of radio astronomy is Mr. Pfeiffer that he takes an extreme stand which would be accepted by few astronomers, either optical or radio. From the seemingly greater width of the radio "window" in the atmosphere he concludes, "We have been shut up in a dungeon for centuries. Now we are in broad daylight." A drawing of an optical-telescope dome overgrown with cobwebs carries the implication that future technical developments will lead to radio astronomy completely superseding optical investigations.

The usual comparison between radio and optical "windows" is expressed in terms of octaves (about ten for radio, one for light), but this is misleading. Because of the long wave lengths of radio astronomy, it covers a frequency range of only about 10,000 megacycles, while optical astronomy, using exceedingly small waves, extends over half a billion megacycles!

In many cases radio astronomers are studying forms of matter that were unobservable optically; they can also reach out to regions beyond the limits of optical telescopes—limits set sometimes by distance, sometimes by obscuration. Radio astronomers do not claim, however, to have "found a new universe." Fundamentally, radio and optical astronomers are studying the same universe, and the results of radio investigations are most meaningful when set against the knowledge gained from optical work. And it is hard to see how radio can ever approach the optical method as a source of detailed information. The greatest future advances should come from close co-operation between the two.

Despite these criticisms, this book can be recommended to any astronomer, amateur or professional, for its broad view of the achievements and future objectives of radio astronomy, leavened with interesting notes about the astronomical fraternity.

FRANK J. KERR
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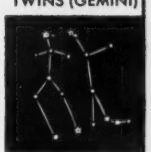

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A SPACE TRAVELER'S GUIDE TO MARS

I. M. Levitt. Henry Holt and Co., Inc., New York, 1956. 175 pages. $3.50.

THE BOOK to which this title should apply will probably not be written for 50 years, since it will very likely be this long before flights to the nearest planets are made. In fact, it is this time scale that is set up by Dr. Levitt himself.

Conditions on the surface of Mars as we can now estimate them are covered in the first six chapters. The justification for mentioning space travel in the title is found in occasional references to the appearances of things to a visitor from the earth or to the problems that such a visitor may encounter. An imaginary trip to Mars is described, with general facts about the planet and its satellites.

A chapter treats George Gamow's theory of the beginning of the universe and Gerard Kuiper's theory of the origin and evolution of the solar system. The last chapter mentions recent experiments in the formation of organic compounds by lightning discharges under conditions that were probably in existence in the early history of the earth. Dr. Levitt also discusses the possibility of life on other planets in the solar system and the probability of life on some of the billion, billion planets thought to exist in the universe.

To the reviewer the material in the appendixes was interesting. The first discusses the length of the Martian day (a little longer than our day) and the Martian year (nearly twice as long as our year). For *Sky and Telescope* readers (May, 1954, page 216), Dr. Levitt has already described the Fels Planetarium Mars clock and presented his calendar for Martians, in which there are 12 months of 56 and 55 days. There would be eight weeks in a month, but to me it seems more appropriate to have months of four weeks, 24 months in a Martian year.

The second appendix gives more details on the lightning experiments, and then suggests that short-wave photons from the sun were needed to provide the spark for life on the dead earth. Therefore, he proposes that volcanos situated near oceans carried up sea spray, containing the appropriate organic matter, high into the atmosphere where it could receive the sun's ultraviolet light.

Since there are many other books about Mars, some of them quite excellent, the reviewer does not especially recommend this one. It does not seem to be presented well for its intended popular audience. The explanation of the 15- or 17-year recurrence of close Mars oppositions could have been made much clearer, and there is evidence of insufficient editing. In several places the author refers to vegetation being definitely present on Mars. Most astronomers, I am sure, will agree that we do not have proof of this, only strong evidence. Dr. Levitt regards the Golay cell as more difficult to use for temperature measurements of Mars than the thermocouple, whereas the opposite is true. There are relatively few photographs, and it is not clear why five of those printed should be of nebulae. One important illustration that is missing is a map of the Martian surface.

WILLIAM M. SINTON
Smithsonian Astrophysical Observatory

THE STARS: STEPPINGSTONES INTO SPACE

Irving Adler. John Day Co., New York, 1956. 128 pages. $2.95.

THIS BOOK does not, as one might anticipate, deal with space travel. It is a well-written account of what we have learned of the stars and how we arrived at this knowledge. Though intended for young readers of about the junior high school level, the aptness of the author's writing makes it enjoyable for those who are further along in years and experience.

Irving Adler approaches his subject by analogy and simplification. His plan for the study of stars is to begin with what is visible to the naked eye, introducing the constellations and the concept of light as a messenger from the stars. This is followed by descriptions of the right, paral-

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lel, and oblique spheres; the daily rotation of the sky; stellar designations; and a touch of constellation lore. The charts, drawn by Ruth Adler, are somewhat small but of excellent quality.

Clear accounts are given of brightness and proper motion, and Kirchhoff's three laws of spectroscopy. Some information is presented on the aberration of starlight, parallactic shifts, the Doppler effect, spectral types, the Hertzsprung-Russell diagram, stellar populations, and other subjects. The book ends with a discussion of the structure of the universe. While some of these topics are rather difficult, we are never made aware of this. Therefore the book is a success, for the reader is never scared away.

Mr. Adler is not an astronomer, but has written several general science books for juniors. There are no major errors to be found in his book—only a few minor slips, such as the statement on page 46 that Canopus is visible in Canada. There may be better introductions to the nature of stars for youngsters, but this reviewer has not seen them. W. E. S.

NEW BOOKS RECEIVED

ADVANCES IN GEOPHYSICS, VOLUME 3, *H. E. Landsberg*, editor, 1956, *Academic Press*. 378 pages. $8.80.

This volume is the third in a series of technical reports on recent progress in the earth sciences; although only two of the seven papers are directly astronomical, all will be of interest as they concern our home planet.

S. F. Singer deals with experiments that may be performed with artificial earth satellites, and Z. Sekera treats recent developments in the study of the polarization of sky light. A. P. Crary discusses arctic ice islands; P. Byerly, subcontinental structure as shown by seismological evidence; E. C. Bullard, A. E. Maxwell, and R. Revelle, heat flow through the deep sea floor; J. A. Jacobs, the interior of the earth; P. H. Jones and H. E. Skibitzke, subsurface geophysical methods in ground-water hydrology.

Each chapter is followed by an extensive bibliography.

SCIENTIFIC USES OF EARTH SATELLITES, *James A. Van Allen*, editor, 1956, *University of Michigan Press*. 316 pages. $10.00.

This book contains 33 of the papers presented at the meeting of the Upper Atmosphere Rocket Research panel in January, 1956, at the University of Michigan. The topics include optical and visual tracking of satellites, satellite instrumentation, and the observations possible from such high-altitude vehicles.

ASTRONOMIE, *Oswald Thomas*, 1956, *Verlag "Das Bergland-Buch,"* Stuttgart, West Germany. 1,011 pages. DM 48.

The previous edition of this well-known German popular book contained 630 pages. In this 7th edition, so much new material has been added that its size is increased by more than 50 per cent. It is an excellent work for those who can read German, being illustrated by hundreds of original charts and many modern astronomical photographs of fine quality.

ATOMIC ENERGY

A. Radcliffe and **E. C. Roberson.** Philosophical Library, Inc., New York, 1956. 142 pages. $4.75.

WITHIN the last 25 years, astronomy has shown new usefulness for other physical sciences since the stars serve as large-scale laboratories for atomic research. Therefore it behooves every astronomer, however amateur, to know something about atoms, atomic energy, and its most notorious application, the atomic bomb.

The Philosophical Library has now published in this country a book written in England to explain these subjects for young people. Unfortunately, the youngest age for which this book is suitable will be perhaps two years higher on this side of the Atlantic, simply because such things as references to a "stone of potatoes" and Mrs. Beaton's cookbook would confuse and not help young Americans.

However, this is a well-written and clearly illustrated treatment of the subject, and many adults with little time to spare will find it a quick, palatable, and authoritative means of learning the essentials about atomic energy. The diagrams by F. H. Holderness are especially clear and helpful.

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UNITRON Reports . . .

TWO NEW UNITRON 4" MODELS are now available, in response to the demand for a clock-driven refractor without the photographic accessories. The new 4" Model 160V is essentially the same as the UNITRON 4" Photo-Equatorial Model 160 with field tripod, but lacks the 2.4" photographic guide telescope with UNICLAMPS, Astro-camera 220, the UNIBALANCE tube assembly, and UNICLAMP camera bracket. Similarly, the new 4" Model 166V is an abbreviated version of the fixed-pier Model 166 in which the aforementioned accessories are also omitted. Any or all of these accessories may be added at any time to convert the telescope into a photographic model.

The clock drive furnished is of the weight-driven type, so that your telescope is completely independent of a source of electric current. Constant speed is maintained by means of a rotating governor, and the driving rate may be changed by turning a control knob. Both Models 160V and 166V come complete with ball-bearing equatorial mounting and slow-motion controls for both declination and right ascension, setting circles and verniers, large 10x 42-mm. view finder, Super rack-and-pinion focusing mechanism with locks, the unique UNIHEX Rotary Eyepiece Selector, sun projecting screen, sunglass, solar aperture diaphragm, cabinets, etc. **Seven** eyepieces are included as standard equipment: 6, 7, 9, 12.5, 18, 25, and 40 mm. Three additional eyepieces are available at extra cost.

UNITRON Model 160V is priced at only $985 complete, and Model 166V at only $1075 complete. Both may be purchased for only 10% down, with up to 24 months to pay the balance.

NEW FEATURES are constantly being introduced in UNITRON Refractors, and we have all but given up trying to keep our catalog illustrations and specifications up to date. Consequently, the new UNITRON owner is more apt than not to find all kinds of extras included which he had not anticipated. For example, the tool and spare hardware kit included with the 4" models is handy to have around if a souvenir collector takes flight with one of the wingnuts. All eyepieces are now coated —a fact which is not mentioned in our literature. Then, there is the graduated focusing scale built

Focusing scale aids astrophotography.

into the rack-and-pinion mechanism of the 4" Models 160 and 166. This proves quite useful when photographing with Astro-camera 220. You will be learning more about such extra features in future advertisements.

THE NEW UNITRON 6" MODEL is about to be offered for sale. You will see and hear more about it very shortly. Since its existence was first hinted at in these pages, models of the UNITRON 6" Refractor have been designed and redesigned, tested and retested, all with a view to making this the finest instrument of its type and size that has ever been offered and truly worthy of the UNITRON reputation for originality and ingenuity. The price will be announced soon and will represent the kind of outstanding value for which UNITRON is justly famous.

One of the accessories to be included with the 6" Model will be a **UNITRON 4", f/5 astro-camera** for photographing star fields. Lenses of the Tessar type are now being tested as well as some new lens designs of our own. An experimental model of this 4" camera is shown here on a modified

Could this be the UNIZOR?

version of our 4" equatorial mounting with weight-driven clock drive, together with our 2.4" photographic guide telescope. Also shown is a star diagonal with built-in illuminating system for crosshair eyepieces and variable brightness control. This assembly—which bears a certain resemblance to an antiaircraft gun—is an interesting unit in itself. The guide telescope can be used, with or without the UNIHEX, for general visual observation, and in connection with Astro-camera 220, for photographing the sun, moon, and planets. Could this be the UNIZOR (**Sky and Telescope**, June, 1955, page 339, q.v.)?

Said UNITRON's postman with his bulging mail sack,
Poetic astronomers are ruining my back.
I shall try to survive
'Til Ides of March arrive
And end this strain on my poor sacroiliac.

The above is by way of noting that UNITRON's limerick contest ended on March 15th, and the judges are now faced with a formidable mountain of mail. The winners will be announced in next month's issue—and **you** may be one of them. This contest was designed to dramatize UNITRON's new "easier" Easy Payment Plan which requires a down payment of only 10%. With such liberal terms available you can hardly afford to be **without** a UNITRON—America's most popular refractor.

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4" PHOTO-EQUATORIAL with clock **$1175**
drive and astro-camera (**$117.50 Down**), with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x, 25x

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- EYEPIECES of the HIGHEST QUALITY: Orthoscopic, Achromatized Symmetrical, Kellner, Huygens. Three to nine eyepieces included with each instrument as standard equipment.
- FINEST MATERIALS throughout. DURALUMINUM TUBE. Moving parts of BRASS carefully machined to close tolerances, and finished in CHROMIUM. No war-surplus components used.
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- EQUATORIAL MODELS have slow-motion controls for *both* declination and right ascension as well as rapid-motion controls. Sturdy TRIPOD.
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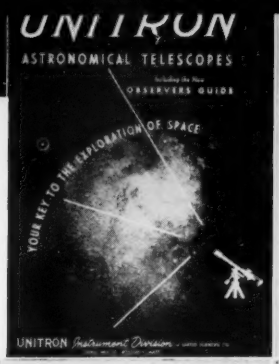

The sample pages shown here in miniature only begin to hint at the wealth of facts and figures included in UNITRON's colorful, 38-page Catalog and Observer's Guide. The full-page illustrated articles on astronomy are crammed with helpful information — not readily available elsewhere — on observing the heavens, telescopes and their mountings, accessories, amateur clubs, astrophotography, and the like. There is even a glossary of telescope and observing terms. Whether you are a beginner or an advanced amateur you will certainly want a copy of this remarkable publication for your bookshelf. Use the handy coupon, a postcard, or letter to request your free copy of this valuable guide.

Those who are considering the purchase of a telescope will find it especially worth while to learn more about the distinguished line of UNITRON Refractors and Accessories which play so important a role in astronomy today. For only by a careful comparison of the features, quality, and performance of different instruments can the prospective buyer insure that his telescope will be worthy of his investment and of the time he will devote to observing. It's truly easy to own a UNITRON. A down payment of only 10% puts you at the controls and you have 12 months to pay the balance. Full information is included in the UNITRON Catalog. Send today for your free copy.

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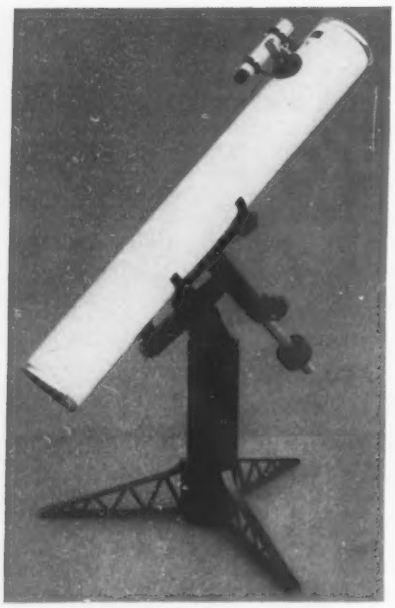

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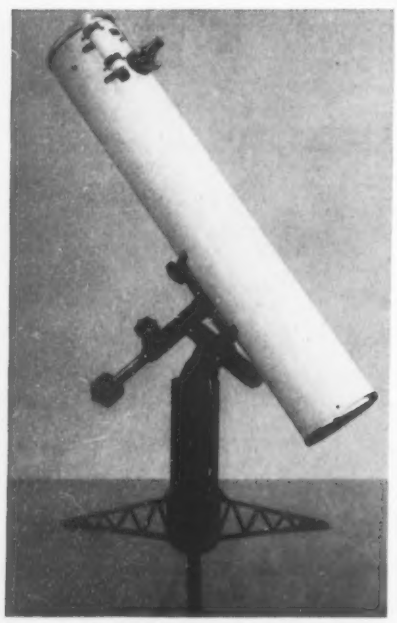

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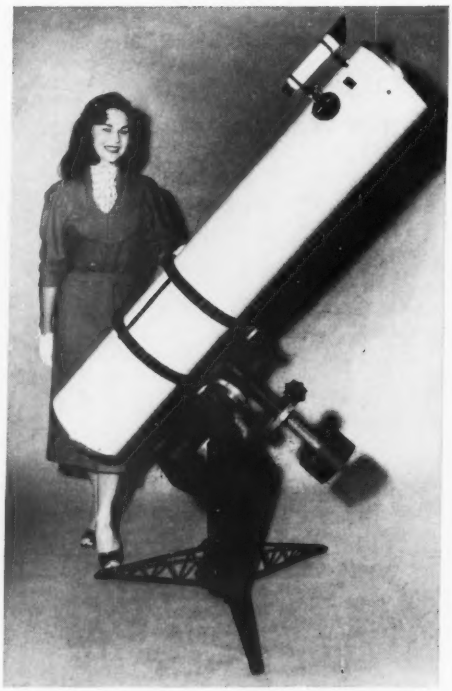

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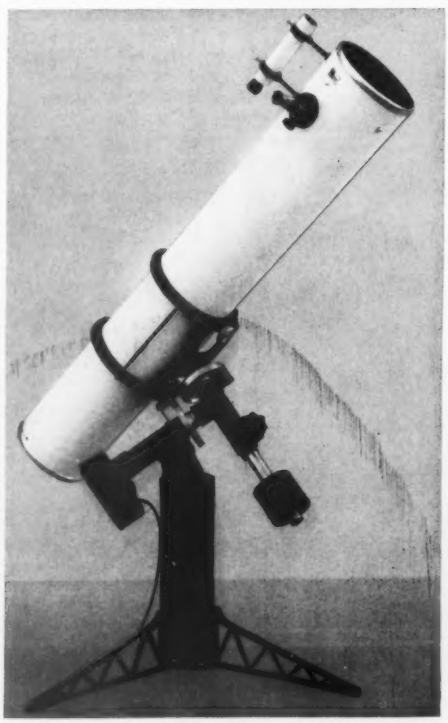

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An Antidiffraction Mask for Reflectors

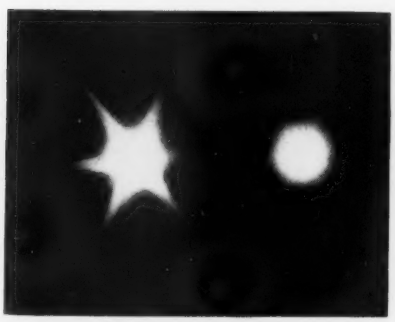
THE PERFORMANCE of a conventional reflecting telescope is impaired by the pattern of bright rays extending out from a star, owing to light diffracted by the supports for the secondary mirror. Many methods have been tried to cure this condition; the one described here has given good results with my 16-inch, f/3.3 reflector, which was pictured on the front cover of *Sky and Telescope* for March, 1952. This instrument can also be used at f/18 as a Gregorian.

It has been suggested (for instance by Frank L. Goodwin, December, 1954, page 75) that to eliminate diffraction spikes a paper mask be placed directly in front of the primary mirror, preventing the shadows of the secondary mirror and the supporting spider legs from falling on the primary. I have developed a masking device composed of circular holes cut in cardboard (or, preferably, in metal).

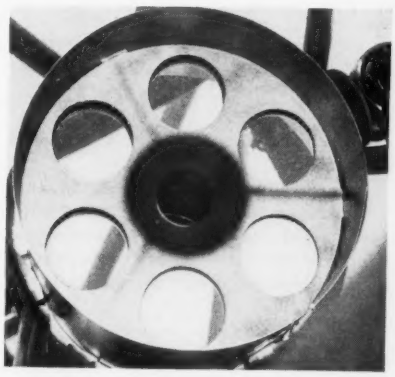
For optimum performance, all holes should be accurately circular and have exactly the same diameter, with clean edges; their centers should be evenly spaced, and no hole should overlap the mirror's edge. By experiment I found that ragged edges gave rise to dozens of needlelike projections from the image of a bright star. Irregular spacing or overlapping the mirror's edge reintroduces diffraction spikes. Attempting to increase the usable area by making the openings other than circular will also result in the formation of spikes.

The mask for my 16-inch telescope contains six holes, each five inches in diameter. A central hole serves the perforation in the primary mirror. The outer six provide enough light to be equivalent to an instrument with an unmasked aperture of slightly over 12 inches. For any use in which this loss of light is a drawback, it is very simple to remove the mask.

I have had to use six holes because my spider support is three-legged. The same arrangement can be used for telescopes in which the secondary is held on a single support. If a four-legged spider is used, the mask should have only four peripheral holes, and relatively more light will be lost, but the gain in resolution is still very significant.



The image of Sirius on the right was made with the mask in place, but the mirror's edge appeared in each hole, resulting in faint traces of spikes.



William A. Rhodes' 16-inch mirror is covered with a cardboard antidiffraction mask. Notice how the shadow of the secondary mirror and the lines cast by the legs of the secondary spider fall outside the carefully positioned holes in the mask.

If an instrument were built using six 5-inch mirrors in place of my present system, the resolving power of the combination would be limited to that of a 5-inch aperture. However, with the mask, all the openings act as mirrors on one common surface, giving an entirely "in-phase" image just as if no mask existed. Due to the number of disks presented, the first diffraction ring is a little more intense, but this effect is offset by the absence of the spikes.

The accompanying test photographs of Sirius were taken at the Gregorian focus on Plus-X film with a few seconds exposure. The left-hand picture was made without the mask, the right-hand with the mask in place. There are faint diffraction spikes around the image with the mask because, at this point in my experiments, the edge of the mirror was overlapped by the holes; when this condition was corrected no spikes were visible in the images.

On the next page, Rigel is shown without and with the mask. One of the spikes covered the companion's position, but that faint star became visible when the mask was used, even though seeing was not good at the time.

Incidentally, in the Rigel picture the unequal size of the rays is caused in part by wires running along one leg of the spider to the selsyn secondary control. It is evident that with the mask one can

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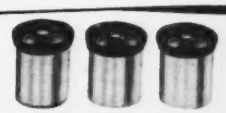

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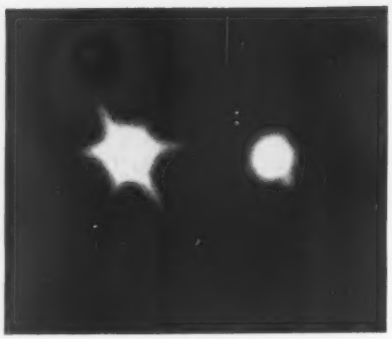

At the left, a diffraction ray hides the companion of Rigel, but the fainter star is visible at the right, in an exposure made with the mask in place.

safely connect various controls to the region of the secondary mirror.

In visual observations using the anti-diffraction mask, star images are smaller and sharper, and close double stars can be split that were not resolvable without the mask. Planetary detail is superb. While the idea of such a mask is not new, its advantages warrant wider use, particularly with reflectors of large aperture.

WILLIAM A. RHODES
4421 N. 14th St.
Phoenix, Ariz.

AN ALL-WEATHER TELESCOPE

DESPITE its appearance, the telescope pictured here is not a Newtonian reflector. The primary mirror is tilted off-axis so the diagonal mirror is to one side, completely out of the way of incoming starlight. This avoids the diffraction that would be caused by a conventional diagonal and its supports. Although the 5½-inch mirror of 122 inches focal length has a spherical figure, the aberrations caused by tilting are quite negligible because of the long focal ratio (f/22). On nights of good seeing, star images are surrounded by faint diffraction rings like those in textbook pictures. Craters on the moon about two miles in diameter can be made out.

The massive mounting was designed for rigidity. The metal parts and tube together weigh over 600 pounds. Both polar and declination axles are of 4″ cold-rolled steel tubing. There are no special castings, the larger parts being made of welded structural steel. Most of the work was done on a 9″ lathe with occasional recourse to a larger machine. The tube rotates in its saddle, and is reinforced paper fiber, weatherproofed by several layers of plastic which was applied with a brush.

The turret eyepiece holder can carry a large 64x ocular and another of standard diameter. Just under the finder is the declination slow-motion control, and a rotary switch for slow motion in right ascension. The driving clock, located in the box above the polar axis, uses a synchronous motor and one of the gear trains described by Paul B. Sweger in *Sky and Telescope* for August, 1955, page 429. It has a differential so that a second motor, controlled from the eyepiece, can change the right ascension setting in either direction. A manually operated clutch disengages the motors when the telescope is moved by a handwheel for rough setting;

A well-built, antivibration mounting makes observing easy with Edgar Everhart's telescope. Nothing has been allowed to interfere with maximum rigidity; even the cradle that holds the rotating tube is oversized, by the standards of most amateurs. The observing ladder and platform rotate around the vertical column supporting the axes, and with the combination of large and small steps the observer can always find a convenient height.

AIRSPACED OBJECTIVES

MOUNTED IN ALUMINUM CELLS f/15

We offer the lowest priced, hand-corrected, precision, American-made astronomical objective, *mounted in a black anodized aluminum cell.* Our reputation has been established over the years as the most reliable source of high quality astronomical lenses.

"Those in the know" BUY FROM US BECAUSE:

Each lens is thoroughly tested by us and is guaranteed to resolve two seconds of arc or better. They are corrected for the C and F lines, as is usual for visual refractors. The zonal spherical aberration and the chromatic variation of spherical aberration are negligible. The cell is machined to close tolerances so that it will fit directly over our standard aluminum tubing, eliminating any mounting problems.

3¼" diam., 48" f.l. (uncoated). **$28.00**
Same as above with coating..... **$32.00**

4⅛" diam., 62" f.l. (uncoated). **$60.00**
Same as above with coating..... **$69.00**

We can supply ALUMINUM TUBING for the above lenses.

"BIG" ACHROMATIC TELESCOPE OBJECTIVES

We have the largest selection of diameters and focal lengths in the United States available for immediate delivery. These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. Not mounted. Fully corrected. Tremendous resolving power. They can readily be used with eyepieces of only ¼" focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100.

Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm (2⅛")	254 mm (10").....	**$12.50**	83 mm (3¼")	660 mm (26").....	**$28.00**
54 mm (2⅛")	300 mm (11.8").....	**12.50**	83 mm (3¼")	711 mm (28").....	**28.00**
54 mm (2⅛")	330 mm (13").....	**12.50**	83 mm (3¼")	762 mm (30").....	**28.00**
54 mm (2⅛")	390 mm (15.4").....	**9.75**	83 mm (3¼")	876 mm (34½").....	**28.00**
54 mm (2⅛")	508 mm (20").....	**12.50**	83 mm (3¼")	1016 mm (40").....	**30.00**
54 mm (2⅛")	600 mm (23½").....	**12.50**	102 mm (4")	876 mm (34½").....	**60.00**
54 mm (2⅛")	762 mm (30").....	**12.50**	108 mm (4¼")	914 mm (36").....	**60.00**
54 mm (2⅛")	1016 mm (40").....	**12.50**	110 mm (4⅜")*	1069 mm (42⅛").....	**60.00**
54 mm (2⅛")	1270 mm (50").....	**12.50**	110 mm (4⅜")	1069 mm (42⅛").....	**67.00**
78 mm (3⅛")	381 mm (15").....	**21.00**	128 mm (5⅛")*	628 mm (24¾").....	**75.00**
80 mm (3⅛")	495 mm (19½").....	**28.00**	128 mm (5⅛")	628 mm (24¾").....	**85.00**
81 mm (3⅜")	622 mm (24½").....	**22.50**	*Not coated		

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American Type

"Zeiss" Type

Beautiful imported binoculars, precision made, at a low, low price. Above we have pictured the two most popular types. The American type offers a superior one-piece frame and a clean design, pleasing to the eye. Complete with carrying case and straps. **Price plus 10% Federal tax.**

SIZE	TYPE	C. FOCUS	IND. FOCUS
6 x 15	OPERA	—	**$12.75**
6 x 30	"ZEISS"	**$18.75**	**16.75**
7 x 35	"ZEISS"	**21.25**	**19.25**
7 x 35	AMERICAN	**23.50**	—
7 x 35	AMERICAN WIDE ANGLE 10°	**37.50**	—
7 x 50	"ZEISS"	**24.95**	**22.50**
7 x 50	AMERICAN	**32.50**	—
8 x 30	"ZEISS"	**21.00**	**18.25**
10 x 50	"ZEISS"	**30.75**	**28.50**
20 x 50	"ZEISS"	**41.50**	**39.50**

MONOCULARS

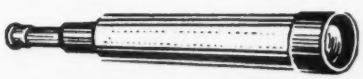
Brand new, coated optics, complete with pigskin case and neck straps.

	Price		Price
6 x 30	**$10.00**	7 x 50	**$15.00**
8 x 30	**11.25**	16 x 50	**17.50**
7 x 35	**12.50**	20 x 50	**20.00**

"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 30 days.

"GIANT" 3" TELESCOPE



40 power Special Price **$57.50**

You rarely find an instrument like this offered at so low a price. Here is another example of American ingenuity. Big 3" diameter achromatic coated objective which will give needle-sharp crystal-clear images. Focusing is a delight with the micrometer spiral focusing drawtube. Light-weight aluminum construction throughout, black crackle finish, length open 22 inches, closed 17 inches. This telescope gives an upright image—it is WONDERFUL for astronomy, SUPERB for long distances, EXCELLENT as a spotting scope.

"GIANT" EYEPIECE

WIDE ANGLE ERFLE (68° Field) **EYEPIECE.** Brand new coated 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1 13/16" aperture. **$12.50**

WIDE ANGLE ERFLE 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field... **$18.50**

1¼" **Diam. Adapter** for above eyepieces. **$3.95**

LENS CLEANING TISSUE — Here is a wonderful Gov't. surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications.

500 sheets size 7½" x 11"..... **$1.00**

MOUNTED EYEPIECES

The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black anodized standard aluminum 1¼" O.D. mounts.

F.L.	TYPE	PRICE
12.5 mm (½")	Symmetrical.....	$ 6.00
16 mm (⅝")	Erfle (wide angle).....	12.50
16 mm (⅝")	Triplet.....	12.50
18 mm (¾")	Symmetrical.....	6.00
22 mm (27/32")	Kellner.....	6.00
32 mm (1¼")	Orthoscopic.....	12.50
35 mm (1⅜")	Symmetrical.....	8.00
55 mm (2 3/16")	Kellner.....	6.00

COATED 75 cents extra.

ASTRONOMICAL MIRRORS

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon monoxide protective coating. You will be pleased with their performance.

	Diam.	F.L.	Postpaid
Plate Glass	3 3/16"	42"	$ 9.75
Pyrex	4¼"	45"	$13.50
Pyrex	6"	60"	$25.00

AN ECONOMICAL EYEPIECE

This mounted eyepiece has two magnesium-fluoride coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x).

The eyepiece cell fits a 1¼" tube..... **$4.50**

Aluminum Telescope Tubing

O.D.	I.D.	Price Per Ft.
2¼"	2⅛"	$1.20
3⅜"	3¼"	1.75
4½"	4⅜"	2.75
5"	4⅞"	2.75

All tubing is shipped POSTPAID.

Focusing Eyepiece Mounts Rack & Pinion Type

The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

For 2⅛" I.D. Tubing	Postpaid	$12.95
For 3¼" I.D. Tubing	"	12.95
For 4⅜" I.D. Tubing	"	12.95

REFLECTOR TYPE FOR ALL SIZE TUBING:
Complete with diagonal holder..... $ 9.95

Aluminum Lens Cells Black Anodized

Cell for Lenses	Cell Fits Tubing	Price
54 mm Diam.	2⅛" I.D.	$ 3.50
78 mm "	3⅜" "	6.50
81 mm "	3¼" "	6.50
83 mm "	3¼" "	6.50
110 mm "	4⅜" "	10.50

3X TELESCOPE

Makes a nice low-priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, wt. 2 lbs.

Gov't. Cost $200. **$9.75**

FIRST-SURFACE MIRRORS

Size	Thickness	Postpaid
14" x 16"	¼"	$10.00
8" x 10"	¼"	4.25
4" x 5"	¼"	1.85
4" x 4"	¼"	1.50
1¼" x 1½"	1/16"	.25

RIGHT-ANGLE PRISMS

8 mm face.....ea.	$ .75	28 mm face.....ea.	$1.75
12 mm face.....ea.	.75	38 mm face.....ea.	2.00
23 mm face.....ea.	1.25	47 mm face.....ea.	3.00

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Dual Finder that swings to either side of eyepiece. Find object with ease, east or west of your meridian.

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Mirror Kits

Complete with pyrex blanks, ceramic tool, six abrasives, pitch, rouge, and cerium oxide.

4¼", 6 lbs....$8.00; 6", 9 lbs....$10.00; 8", 14 lbs....$15.95; 10", 35 lbs....$28.95; 12½", 55 lbs....$45.00

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Circles, photo-printed:
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COMPLETE MIRROR REFIGURING SERVICE
NO CHARGE FOR TESTING YOUR MIRROR
Mirrors ground to order.

ALUMINIZING
with extra hard quartz coating.

FREE Catalogue. Instructions, 10¢.

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Here are the best oculars obtainable for the price, made with fine optics and tested individually in our laboratory — a real buy at a cost you can afford.

Ramsden and Huygens Eyepieces
½", ¾", 1".....$6.70 each, postpaid

Achromatic Eyepieces
¼", ½", ¾", 1".....$15.25 each, postpaid

Each is beautifully mounted to fit standard 1¼" holder. The barrel is nickel plated, the rest black anodized. Above eyepieces come with crosswires at a slightly higher price.

Focusing mounts and finders also available.

Write for Bulletin 10.

PERRY INSTRUMENT CO.

202 Maple St., Weehawken, N. J.

tiny neon lights illuminate the two setting circles.

No observatory is planned to protect the telescope from rain and snow. All motors and small gears are enclosed, and there are caps for both ends of the tube. A tarpaulin can cover the eyepiece holders and the finder.

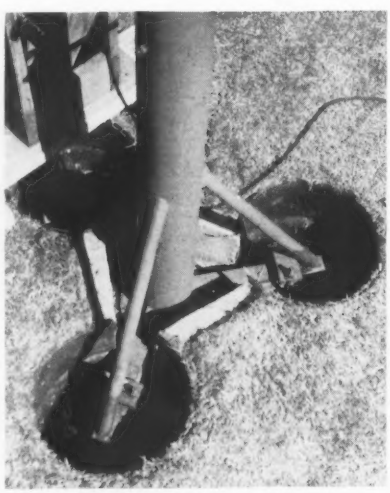
Many visitors, including groups of grade school and university students, have observed with this instrument. For such demonstrations, the clock drive is a great convenience. The mounting and tube can accommodate a much larger mirror, and a 10-inch f/12.5 is already under construction.

EDGAR EVERHART
Wormwood Hill
Mansfield Center, Conn.

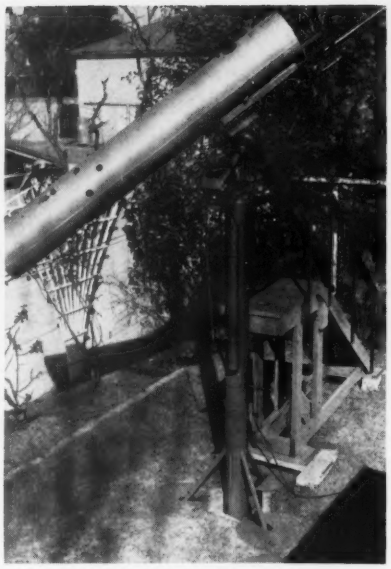
A VIBRATION-PROOF MOUNTING SUPPORT

IN mounting my 12-inch Springfield telescope I was faced with the problem of vibration caused by heavy motor traffic on a street within a hundred feet of my observing site. The solution was to support the whole mounting on shock absorbers.

The telescope pier is a heavy-duty steel well-casing. To its lower end three I-beams were welded, extending horizontally outward. To support the ends of these beams, three 50-gallon oil drums, both ends removed, were set vertically in the ground, and in each of these was placed a 30-gallon drum filled with concrete. A U-bolt was set in the wet concrete. The pier was then set so that each beam end passed through its U-bolt. However, the beam rests not on concrete but on a rubber block—a heavy-duty shock absorber from a caterpillar tractor. On top of each I-beam another rubber block was placed. A steel plate was then fitted over the upper block, and the whole assembly was clamped rigidly by the U-bolts.



The covers have been removed from the three shock-absorber supports that are set in 50-gallon oil drums.



The complete 12-inch Springfield telescope of Earle R. Bunker, showing the long pier necessary to allow the 8-foot tube to clear the ground. Note the covers on the three wells around the base of the pier through which the bracing rods extend.

In this way the mounting floats between the rubber blocks. There is no vibration from traffic, even with a power of 425. During the year that the telescope has been in use, the continual compression of the rubber blocks has not resulted in their deterioration.

EARLE R. BUNKER
315 Harvard St.
Fresno, Calif.

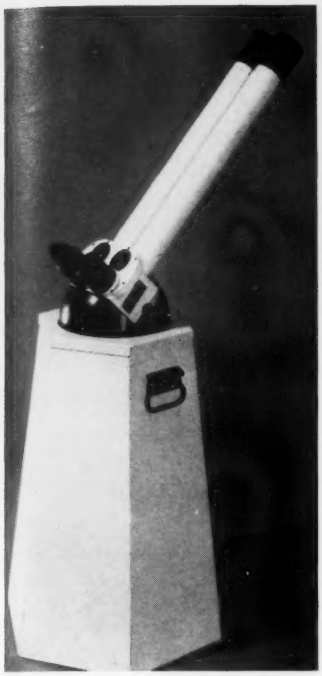
A BOWLING-BALL MOUNTING

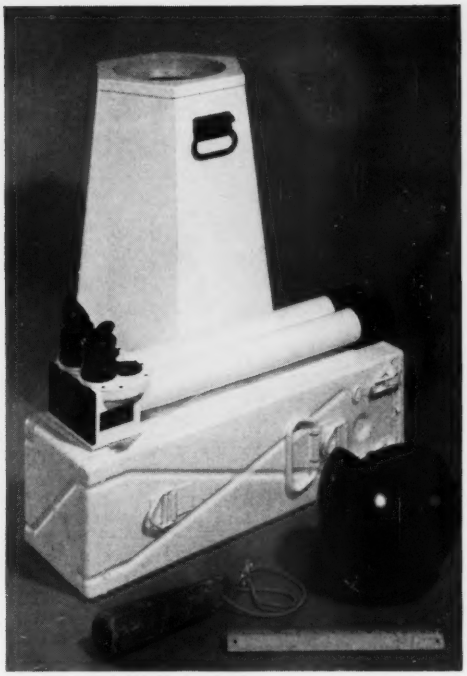
ONE war-surplus item currently on the market is the M-17 elbow telescope. It contains a 50-millimeter achromatic objective with a focal length of 224 millimeters, an Amici erecting prism, and an eyepiece of 28 millimeters focal length, 50-degree apparent field, in a focusing mount.

This eyepiece is not a simple Kellner, but has two achromatic lenses (four components) mounted with their faces almost in contact. Red, orange, and neutral filters, and a crosshair reticle complete the optical assembly.

If two of these M-17 instruments are procured, very little machine work is required to bolt them together with their optical axes parallel. The filters and reticles are removed. The separation of the axes should be 67 millimeters, which is the interpupillary distance of the average adult, but each amateur should first check the spacing between his own eyes.

The resulting 8x wide-field binocular, which can be hand held, is fine for both terrestrial and astronomical observation.





Paul E. Shaad has mounted a pair of M-17 elbow telescopes on a bowling ball, changing the objectives to make a 22-power binocular. The right-hand picture shows the bearing surface for the bowling ball, the war-surplus container that makes a carrying case, and the 10-pound lead counterweight, which in use is suspended from a fixture attached to the underside of the ball. This fixture is visible above the ruler.

It is collimated easily and accurately by adjusting the Amici prisms in their mountings, which are designed for this purpose.

A modification of such a pair of binoculars is illustrated here. The objective barrels have been partially cut off on a lathe and extensions of two-inch aluminum tubing attached. The original objective lens cells were slightly enlarged to fit a pair of war-surplus 54-millimeter achromatic lenses of 600 millimeters focal length.

As this change raises the magnification to 22x, a good steady mounting becomes essential. The one shown was made from a discarded bowling ball, about 16 pounds, out of which a quarter section had been cut by hand with a sharp carpenter's crosscut saw. The bowling ball sits in a socket turned in a slab of soft wood.

This mounting operates splendidly. It is heavy, easily balanced, and with the ball polished the binocular is quickly and smoothly pointed to any part of the sky. The eyepiece location remains comfortable for a seated observer, which is a great aid to prolonged observing.

By coincidence, a war-surplus A-13 emergency sustenance kit container just fits this binocular telescope, as the picture shows. It provides dustproof transportation and storage of the instrument.

PAUL E. SHAAD
1137 43rd St.
Sacramento, Calif.

TRIPLES 'SCOPE PERFORMANCE!

Sharper images, wider field, more light at higher powers! A startling statement positively proven in 16-page telescopic educational matter sent free on receipt of self-addressed long envelope bearing nine cents (9c) return postage.

First, the Goodwin Resolving Power lens placed in front of eyepiece gives three times the magnification on each by lengthening your primary focal length angle up to three times, yet extends eyepiece out no more than two inches from normal. This alone sharpens definition.

Next, by achieving your highest powers on more comfortable low-power eyepieces, you lessen image deteriorations due to short-focus acute bending of the convergent beam, since all usual eyepieces are f/1 or less. Again sharper images from this highest precision lens.

Third, you get greater illumination and wider field by relieving tiny aperture restrictions of higher-power eyepieces.

The Resolving Power lens is achromatic, coated, gives flat field sharp to the edge. Here is astonishment! Price $17.50 in 4" long adapter tube fitting standard 1¼" eyepiece holders ONLY (also adaptable to Unitrons. State if Unitron.) Money back if not positively thrilled after two weeks trial! Used and praised by legions!

No COD's — Colleges and Observatories may send purchase order.

FRANK GOODWIN
345 Belden Ave., Chicago 14, Ill.

Read This Advertisement

Here is a combination of a Barlow and a particular ocular which gives outstanding results. It consists of our new Barlow and our 16.3-mm. (⅔" focal length) Erfle eyepiece. While the Barlow was not specifically designed to work with this eyepiece, it does so to an astonishing degree. All images are sharp and hard to the very edge of the field.

The Barlow gives magnification up to slightly over three times that of the ocular alone. It is achromatic, coated, and mounted to the U. S. standard size of 1.250 inches.

The modified Erfle eyepiece has a field of 75 degrees with excellent eye relief. The combination gives the equivalent focal length of slightly under 6 mm. Many users state it is far superior to any shorter focal length ocular of equivalent magnification.

The Barlow sells for $16.00 postpaid, and the Erfle for $14.75 postpaid. Both are guaranteed to perform as above stated or money refunded.

ORTHOSCOPIC OCULARS—All hard coated, standard 1¼-inch outside diameter.

28-mm.	$15.00	10.5-mm.	$16.25	4-mm.	$17.25
16.3-mm. (Erfle)	$14.75	7-mm.	$17.25	Barlow 3x	$16.00

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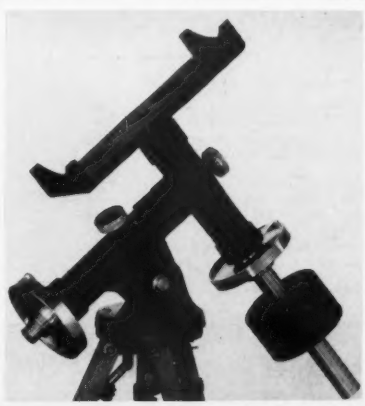
1000 North Seward Street
Los Angeles 38, Calif.

Warranted to equal or surpass any oculars obtainable anywhere or money refunded.

Finished mirrors, mirror kits, spiders, elliptical flats, focusing devices, aluminizing.

Send for catalogue.



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Look at these features—

1. Latitude adjustment.
2. 1¼" x 17" declination shaft.
3. Ball-bearing polar-axis shaft, 1½" on north end —1" on south end x 12" long. Suitable for clock drive.
4. High tensile aluminum black-finish castings, with solid-steel shafts.
5. 11-pound cast-iron balance weight.
6. Locking screws on polar and declination axles.
7. 5" brass setting circles with pointers.
8. Weight approximately 38 pounds complete.
9. Custom-made saddle to fit your telescope.

State size of tube, up to 12". Tripod not included.

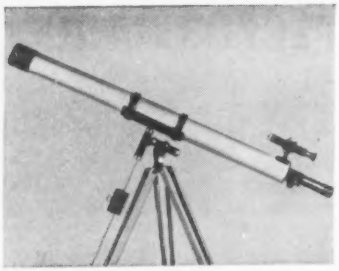
With setting circles .....**$125.00** f.o.b. Arvada
Without circles ..... **$96.00** f.o.b. Arvada

SETTING CIRCLES — State hole sizes.

	Aluminum	*Brass*
5" circles, set of two	**$12.00**	**$15.60**
6" circles, set of two	**$13.00**	**$16.90**
8" circles, set of two	**$20.00**	**$26.00**

O. MAGNUSSON
14560 West 52nd Ave., Arvada, Colorado

3″ ASTRONOMICAL REFRACTOR TELESCOPE



A good-looking, complete instrument, ready to use. Reveals the wonders of the sky in sharp, clear detail. The 3″ air-spaced achromatic objective (low-reflection coated) has been tested by experienced observers who pronounce it equal to any you can buy at reasonable cost. An excellent telescope at an amazingly low price. Rack-and-pinion eyepiece holder of cast aluminum—focusing tube of chrome-plated brass. Takes standard 1¼″ eyepieces. We supply two eyepieces and a Barlow lens, giving powers of 40X, 90X, 120X, 270X. Optical finder telescope, 5-power, with crosslines. Hardwood tripod, 60″ long. Equatorial mounting makes following a star very easy. FREE STAR CHART AND STAR BOOK INCLUDED.

Stock #85,032-Y ..... **$125.00** f.o.b.
(Shipping wt. 30 lbs.) Barrington, N. J.

3″ "PALOMAR, JR." REFLECTOR

60- to 120-Power — An Unusual Buy!

Assembled—ready to use! See Saturn's rings, the planet Mars, huge craters on the moon, star clusters, moons of Jupiter, galaxies! Nonbreakable aluminum covered tube. Equatorial mount with lock on both axes. Aluminized and overcoated 3″ diameter f/10 primary mirror, ventilated cell. Telescope comes equipped with a 60X eyepiece and a mounted Barlow lens, giving you 60 to 120 power. A finder telescope, always so essential, included. Sturdy, hardwood, portable tripod.

Free with scope: Valuable STAR CHART and 136-page book, "Discover the Stars."

Stock #85,050-Y ..... **$29.50** f.o.b.
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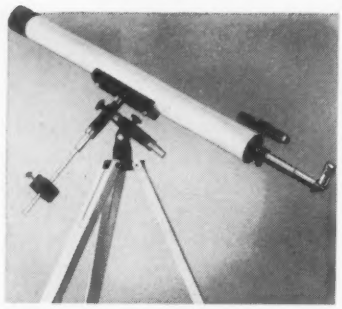
SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope—by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows moons of Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36″ high on removable legs. Adjustable 3″ polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle — swings to any location in the sky. Fascinating 18-page instruction book; sturdy carrying case.

Stock #70,068-Y ..... **$14.95 ppd.**

4″ REFRACTOR TELESCOPE

240-POWER

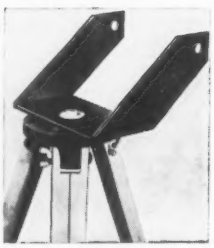


Complete with Finder, Equatorial Mounting, Tripod, Eyepiece Extension, Star Diagonal, and Three Eyepieces

Our newest development. Built for rugged use, quality performance. Mounting made from heavy iron castings with machined bearings for smooth operation. Tripod has extra-heavy 60″ hardwood legs. Telescope's weight is 42 lbs., giving stable, steady viewing. Big 4″ objective is an air-spaced achromat, each element coated on both sides for low reflection. Three eyepieces supplied give you 48X, 120X, and 240X. Special Barlow lens also gives up to 500X. Star diagonal included for comfortable viewing at high angles. Rack-and-pinion focusing. All metal parts are plated to prevent rusting. Finder is 8 power. The usual price for a 4″ refractor of comparable quality is over $400, so our new model saves you almost 40%.

Stock #85,038-Y ..... **$247.00** f.o.b.
(Shipping wt. 55 lbs.) Barrington, N. J.

LOW-COST TRIPOD AND ALTAZIMUTH MOUNT



Put your telescope to use as soon as it's finished, by using this mount. Later you can remove the offset yoke and bolt an equatorial mounting of pipe fittings or other parts to the tripod head. Or, if you don't need a portable telescope, buy only the offset yoke to bolt to a post in the ground. Takes tubing up to 7½″ outside diameter. This yoke is made of ¼″-thick painted steel plate. The tripod head is machined cast iron, 6½″ diameter, gray crinkle. The three sturdy hardwood legs are 32″ long.

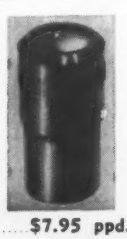
Tripod and Offset Yoke
Stock #85,037-Y **$19.50**

Offset Yoke only
Stock #85,042-Y **$9.95**

Tripod Head and Legs only
Stock #85,043-Y **$12.50**

All above items are f.o.b. Barrington, N. J.

WAR-SURPLUS TELESCOPE EYEPIECE



Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28-mm., eye relief 22-mm. An extension added, O.D. 1¼″, standard for most types of telescopes. Govt. cost $26.50.

Stock #5223-Y ..... **$7.95 ppd.**

EDSCORP SATELLITE TELESCOPE

THE STORY: From the beginning of the visual satellite program, Edmund Scientific Co. was consulted by the Coordinator of Visual Satellite Observations of the Smithsonian Astrophysical Observatory in order to find existing optical instruments or to help in the development of new ones to meet the unique requirements of MOONWATCH. Every effort was to be made to get an instrument with the greatest possible field, which would still have the ability to observe faint objects with only moderate magnification. All this was to be provided at a minimum cost. More than thirty different optical arrangements were examined and evaluated by expert advisors to the MOONWATCH program. The optics which we have used have been described in the *Bulletin for Visual Observers of Satellites* as providing one of the best combinations for the purpose.

OPTICS: The Satellite Scope has two important optical characteristics: A wide (51-mm.) diameter, low-reflection-coated objective lens. A six-element extremely wide field, coated Erfle eyepiece that, in combination with the objective, gives 5.5 power with a big 12° field and over 7-mm. exit pupil.

MOUNT: The mount came in for special attention because of unique requirements of group observing. The center of rotation of the instrument is just below the point where the optical axis is deflected by the front-surface mirror. The mirror is set at 45° to the axis of the telescope barrel and reflects light at exactly 90°. Side brackets and wing nuts permit fast, easy elevation and rigid locking. Rubber eyeguards and the angle of the telescope permit the greatest comfort in long-time viewing. The wide field and our special mount permit the utmost coverage of the possible passage of the satellite without omission of an area of the sky by a string of observers.

OTHER USES FOR THE SATELLITE SCOPE

1. Makes a perfect wide-field finder. A special groove on the barrel helps in locating it in the finder mount. Fits our twin-ring finder mount, Stock No. 70,079-Y—$9.95. **2.** Use the Erfle eyepiece on your regular astronomical telescope. You will need our adapter, Stock No. 30,171-Y — $3.95, which gives you an O.D. of 1¼″. This eyepiece cost the government $56.00! **3.** Makes a wonderful comet seeker; see complete asterisms. **4.** Makes a fine rich-field telescope; see wide areas of sky with deep penetration.

Especially Made for Members of MOONWATCH
Stock #70,074-Y ..... **$49.50 ppd.**

ATTENTION!

Here's An Interesting "Do-It-Yourself" Project

If you want to build your own Satellite Scope, we can supply the optical parts, or any metal parts from our assembled Satellite Scope. We'll be glad to send you full description of these components together with price information.

WRITE FOR SATELLITE BULLETIN #40-Y

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞″	5¼″	46″	Spiral-wound paper	$2.50
85,008-Y	6⅞″	7⅝″	60″	Spiral-wound paper	4.00
85,011-Y	2⅞″	3″	48″	Aluminum	6.00
85,012-Y	3⅞″	4″	60″	Aluminum	8.75
85,013-Y	4⅞″	5″	48″	Aluminum	9.00
85,014-Y	6⅞″	7″	60″	Aluminum	15.00

All tubing is shipped f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CO.

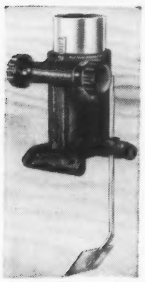
WAR-SURPLUS KELLNER EYEPIECE

Mounted — Ready to Use — 1¼" Outside Diameter — Coated — 1¼" Focal Length

Consists of an achromatic eye lens and an achromatic doublet field lens (Gov't. cost about $30). The clear aperture of the lenses is approximately 1", giving wide exit pupil and a clear image. Excellent for any telescope when low power and a wide field are needed. Try it for 10 days—if you don't agree that the performance is better than any commercial type selling for two or three times our price, we will refund your money in full.

Stock #50,130-Y ..... **$5.90 ppd.**

Rack & Pinion Eyepiece Mounts



For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope—the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder) $9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAM.
6-mm. (¼") Focal Length
Stock #30,063-Y ..... **$8.50 ppd.**

12.5-mm. (½") Focal Length
Stock #30,064-Y ..... **$8.00 ppd.**

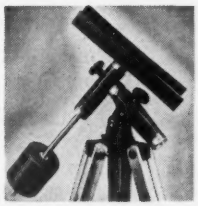
COMBINATION EYEPIECE — 10-mm. and 20-mm.
Stock #30,065-Y ..... **$9.00 ppd.**

7X — FINDER TELESCOPE — ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts **$9.95**

Stock #50,075-Y Ring mounts per pr., $3.95

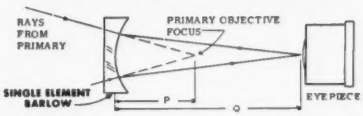
HEAVY-DUTY EQUATORIAL MOUNT AND TRIPOD for 6"-8" REFLECTING TELESCOPE



Heavy cast base with sturdy 32" long hardwood legs. 1" shafts. Boston bronze bearings to provide a uniform film of lubrication over entire bearing surface and assure smooth operation. Big locking knobs 1⅜" on both declination and polar axes. Polar axis variable for latitude adjustment. 12" cradle securely holds 3" to 10" tubes. Beautifully finished in baked black crinkle paint. Legs can be removed easily for permanent post mounting. Height 38", weight 32 lbs.

Stock #85.023-Y ..... **$49.50 f.o.b.**

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!

Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of −1⅝". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned—no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens $8.00 ppd.

ATTENTION—BEGINNERS AND JUNIOR ASTRONOMY CLUBS

To solve the problem of low-cost lenses of good quality for a beginner's telescope we have had these achromatic lenses designed and mass produced. Our first shipment is in. They are swell!

ACHROMATIC OBJECTIVE, 32-mm. diam. (1¼"), F.L. 31", (Will get 62X with ½" eyepiece; 124X with ¼" eyepiece)
Stock #30,201-Y ..... **$2.50 ppd.**

ACHROMATIC OBJECTIVE, 42-mm. diam. (1 21/32"), F.L. 41". (Will get 41X with 1" eyepiece; 82X with ½"; and 164X with ¼")
Stock #30,202-Y ..... **$4.00 ppd.**

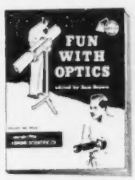
UNMOUNTED SETS OF RAMSDEN EYEPIECE LENSES
Stock #30,210-Y ..... **½" eyepiece set** **$1.50**
Stock #30,208-Y ..... **¼" eyepiece set** **$1.75**

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead on refractor telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y ..... **$12.00 ppd.**

FUN WITH OPTICS



New booklet. 32 pages. Completely illustrated. Shows you how to build many types of optical instruments: plus lens primer showing various types of lenses and how they work, optical illusions, etc.

Simple, easy-to-follow directions for building astronomical telescopes, terrestrial telescopes, artist's drawing projectors, reflex slide viewers, magnifiers, miniature monoculars, transparency projectors and many other optical instruments.

No technical knowledge is needed. Youngsters or grownups can have a lot of fun learning about optics and building their own optical instruments using lenses, prisms, etc., purchased from us.

Stock #9050-Y ..... **$.50 ppd.**

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y ..... **$16.25 ppd.**

8X FINDER TELESCOPE

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y ..... **$8.00 ppd.**

MISCELLANEOUS ITEMS

KELLNER EYEPIECE — 2" focal length (1¼" O.D.). Mount of black anodized aluminum.
Stock #30,189-Y ..... **$6.00 ppd.**

60° SPECTROMETER PRISM — Polished surfaces 18-mm. x 30-mm. — flat to ½ wave length.
Stock #30,143-Y ..... **$8.25 ppd.**

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16". O.D. 1-5/16".

Stock #40,165-Y ..... **$1.75 ppd.**

30-day Money Back Guarantee as with all our Merchandise!

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Fantastic variety—never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

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(1) SUPER-RIGID MOUNTING — massive aluminum castings, 1½-inch shafts. Surprisingly light—6-inch or 8-inch scope, about 85 pounds.

(2) REMOVABLE BALL-BEARING CASTERS — screw-down legs.

(3) FIBERGLASS FEATHER-LIGHT TUBE.

(4) FINDING SCOPE — 50-mm. objective — helical focusing.

(5) SYNCRO-MESH RACK-AND-PINION FOCUSING SYSTEM.

(6) SUPERB OPTICS — f/8 parabolic pyrex mirrors — guaranteed ⅛ wave and to resolve to Dawes' limit on good nights.

(7) OCULARS (EYEPIECES) — any three of these eyepieces: 28-mm., 22-mm., 16-mm., 11-mm., 7-mm., 6-mm., 4-mm. — or any two eyepieces and a Goodwin Resolving Power Barlow lens.

(8) CLOCK DRIVES — standard 110-volt or the fabulous ASTRO-FIX.

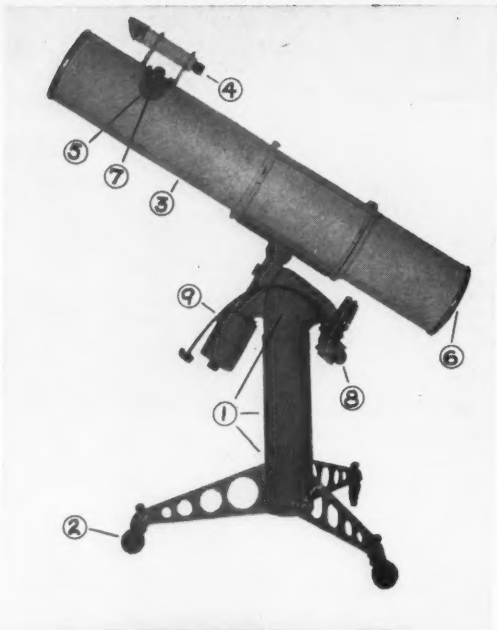
(9) MANUAL FLEX-LINE CONTROL.

- COMPLETE PORTABILITY — assembled or disassembled in minutes.
- EXPOSED FOCAL PLANE—for convenient astrophotography.

8-inch Standard $375.00

	Standard	*De Luxe*
6-inch	$295.00	$495.00
8-inch	$375.00	$575.00
10-inch	$675.00	$875.00
12½-inch	$995.00	$1150.00

All De Luxe models come equipped with clock drive, manual flex-line drive, setting circles, full rotating tube, and removable casters.



Illustrated above is the 8-inch De Luxe.

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New type 10-inch, and larger, TRECKERSCOPES

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Open to all amateur astronomers in the United States

Enter now. See page 188 of the February issue for details. Each month's winner will be notified by mail, and will receive this beautiful trophy.

Mirrors and diagonal flats made of fused quartz now available — write for more information

"TRECKER-PATHFINDER"

EQUATORIAL MOUNT

$74.50 complete . . . . . This mount will accommodate 4-inch to 8-inch telescopes.

Standard 36-inch height — massive 1½-inch steel shafting

This amazing NEW EQUATORIAL MOUNT is just what the doctor ordered when it comes to "How to mount that homemade telescope you labored so hard to finish." Now — at last — you can purchase a beautifully constructed, highly rigid equatorial mount, COMPLETE, for your own telescope as economically as if you had built it yourself. This terrific new mount is made entirely of metal; all of the moving equatorial parts are polished to work with maximum ease. Legs, head, and counterweight are all removable for easy storing. One of the more important features in this new mount is that the polar axle is extended for ease in attaching a clock drive and/or setting circles, which may be added at any time. The "TRECKER-PATHFINDER" mount also has a beautiful, chip-resistant finish. Taking all of these unusual features into consideration, this is truly one of the best DOLLAR-FOR-DOLLAR values ever offered.

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Skeleton type

6-inch $6.50

8-inch	$10.95
10-inch	$17.95
12½-inch	$21.00

All prices f.o.b. Long Beach, and subject to change without notice. California residents: Add 4% sales tax to all prices.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

The Solar Eclipse of April 29-30, 1957

OBSERVERS in the northwestern part of the United States may see the sun partially eclipsed just before sunset on Monday, April 29th. This eclipse will be annular in the Russian Arctic, but in this country only a small fraction of the sun will be covered, even at mid-eclipse.

Amateurs with telescopes can view the phenomenon by projecting the solar image on a white screen held behind the eyepiece, or by using suitable dark filters. Naked-eye observers can watch the eclipse with safety from a room with a western exposure, if a drawn window shade is pierced with a small hole. A pinhole image of the sun is then cast on the opposite wall, and the "bite" from the sun can be recognized.

The foregoing schedule for the eclipse is adapted from the *American Ephemeris and Nautical Almanac*. All times given are p.m., standard time for the zone indicated. The omission of a particular phase indicates that it occurs below the horizon. The fraction of the sun's diameter, *F*, covered at mid-eclipse is given in the last column. For Minneapolis, Minnesota, and Pierre, South Dakota, where mid-eclipse occurs after sunset, the values of *F* at sunset are 0.14 and 0.19, respectively.

This relatively unspectacular solar eclipse will be the last such event to be visible in the United States until October 2, 1959, when an early-morning eclipse will be observable from the eastern part of the country.

Place	*Zone*	*Start*	*Middle*	*End*	*Sunset*	*F*
Denver, Colo.	MST	6:31	6:50	.....	6:52	0.05
Boise, Idaho	MST	6:22	6:47	7:11	7:46	0.08
Minneapolis, Minn.	CST	7:02	.....	.....	7:16	.....
Helena, Mont.	MST	6:07	6:43	7:17	7:35	0.17
Bismarck, N. D.	CST	7:02	7:41	.....	7:52	0.24
Portland, Ore.	PST	5:15	5:43	6:10	7:15	0.09
Pierre, S. D.	CST	7:09	.....	.....	7:41	.....
Salt Lake City, Utah	MST	6:34	6:50	7:06	7:21	0.03
Seattle, Wash.	PST	5:05	5:40	6:14	7:20	0.14
Cheyenne, Wyo.	MST	6:24	6:49	.....	6:53	0.09

Twelve years ago, on July 9, 1945, in Flushing, New York, R. E. Massot photographed the partially eclipsed sun. Having no screen large enough, he projected the six-foot image of the sun on the wall of his bedroom with a 6-inch Newtonian reflector.

COMET NEWS

BY FAR the brightest and most interesting comet in the spring sky is 1956h, discovered by Arend and Roland in Belgium last November. At the beginning of April it is too near the sun to be visible, but by month's end its rapid northward motion will place it in the northwestern evening sky. Even though Comet Arend-Roland has not brightened as rapidly as was at first expected, it should be fairly conspicuous. The following reports supplement the account on page 244 of the March issue, which contains an ephemeris and a chart of the comet's path.

On a photograph secured on January 27th, by Dr. R. Waterfield, Ascot, England, the comet's tail was at least half a degree long and slightly fan-shaped. The coma was strongly condensed, with a diameter of about 44,000 miles. On January 31st, H. L. Giclas photographed the comet with the 13-inch Lowell Observatory refractor, his exposure being only six minutes long, in order to get a weak cometary image suitable for position measurements. The comet was of magnitude 9.0, with a nearly stellar nucleus. At the University of Michigan Observatory, Dr. Freeman B. Miller has been photographing the comet, and Dr. William Liller has been scanning its spectrum photoelectrically with a monochromator and a 20-stage Lallemand photomultiplier.

During February, the comet was near-

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With new velvet-finishing tools.

Diameter	
4¼"	$5.70 postpaid
6"	9.50 postpaid
8"	12.25 shipped collect
10"	21.75 shipped collect
12½"	41.25 shipped collect

Kits include five abrasives with our special superfine finishing abrasive for superior fine grind, selected pitch, cerium oxide, pyrex mirror, and velvet-finishing tool (heat resistant, approximate hardness of pyrex). C.O.D.'s accepted.

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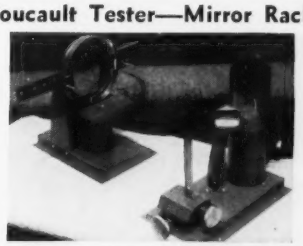

- Steel construction—baked-on enamel finish.
- Microaction on knife edge.
- Cool pinhole with ¼-wave 1¼" perfect prism.
- Mirror rack adjustable for mirrors from 4¼" to 12½".

Tester and rack only $24.95 postpaid

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Precision Diagonals

You will get the best possible performance from your telescope with one of our clear **fused quartz** diagonals. Accuracy guaranteed 1/20 wave.

Ellipse 1.25" x 1.77" . . $11.00
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Pyrex diagonals, ⅛ wave accuracy.

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Ellipse 1.5" x 2.12" . . $ 8.00

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SKY PUBLISHING CORPORATION

Harvard Observatory, Cambridge 38, Mass.

ing the sun, and could be seen only briefly after sundown low in the southwest. One of the last photographs before it was lost in the daylight was made on February 22nd, by Dr. G. Van Biesbroeck with the 24-inch reflector at Yerkes Observatory, who estimated the magnitude visually as 8.4. He reported that the comet remained systematically fainter than was forecast although its motion followed the predictions well.

The orbit of Comet Arend-Roland appears to be hyperbolic, according to calculations by M. P. Candy in England, based on 76 observed positions from November 7, 1956, to this January 26th. He finds that the nearest approach to the sun will take place on April 8th at 2:33 UT, at a distance of about 29,500,000 miles.

The following two-day ephemeris of Comet Arend-Roland is abridged from Mr. Candy's predictions in *Circular* 1585 of the International Astronomical Union. For 0^h Universal time of each date listed are given the comet's right ascension and declination (1950.0), and the predicted magnitude. However, it is likely that the comet will be about one to two magnitudes fainter than given here.

April 18, 1^h 26^m.2, +16° 32′, −0.3; **20,** 1^h 42^m.5, +24° 48′, 0.0; **22,** 2^h 01^m.5, +32° 51′, +0.4; **24,** 2^h 23^m.2, +40° 07′, +0.8; **26,** 2^h 47^m.1, +46° 16′, +1.2; **28,** 3^h 12^m.7, +51° 12′, +1.7; **30,** 3^h 39^m.2, +55° 01′, +2.1. **May 2,** 4^h 05^m.9, +57° 52′, +2.5; **4,** 4^h 32^m.0, +59° 57′, +2.9; **6,** 4^h 56^m.8, +61° 24′, +3.3; **8,** 5^h 19^m.8, +62° 22′, +3.7; **10,** 5^h 41^m.0, +63° 00′, +4.0.

JUNIOR ASTRONOMER PHOTOGRAPHS A METEOR

On July 13, 1956, from 3:30 to 3:45 a.m., Dennis Milon was photographing the region of Cassiopeia with a Kodak Autographic Brownie 2-A attached to an 8-inch Astrola reflector with clock drive. He was not watching the sky during this unguided exposure, and so did not see the bright meteor that flashed across the field. It must have been quite brilliant to leave an image stronger than those of the 2nd-magnitude stars on the 15-minute exposure, since the moving meteor could have lasted only a few seconds.

The camera is of the folding type and over 30 years old. Its 10-mm. lens works at f/11, giving a field about 30 by 40 degrees. At the top of the photograph, four stars in the "W" of Cassiopeia are seen.

Mr. Milon is a member of the Lamar Astronomy Club, which meets on the third Friday of each month at Lamar High School.

This bright meteor was photographed by Dennis Milon last July in nearly the same sky area as the one recorded by Walter Palmstorfer in August and reproduced on page 301.

CHARLES Y. PRESCOTT
5080 Fieldwood Drive
Houston 19, Tex.

DEEP-SKY WONDERS

OUR ATTENTION turns this month to one of the best clusters in the sky, M35 or NGC 2168, and to a little known cluster, NGC 2158, only about half a degree south preceding it.

Located at right ascension 6^h 05^m.8, declination +24° 21′ (1950), in Gemini very near the summer solstice point, M35 is bright enough to be seen by the naked eye on clear moonless evenings. Even in finders it is "a piece of frosted silver over which a twinkling light is playing." Larger scopes extend and multiply its starry motes, until in a 10-inch it fills most of the field of an Erfle eyepiece; its diameter is as much as 40 minutes of arc.

In February this year, while checking a new eyepiece holder for its range-of-focus travel, I picked out M35, and was astonished to find a bright "nebula" close by. The stranger was irregular, not uniformly bright, and had sharp projections. It made me think of the brighter parts of the Orion nebula, as no stellar content could be detected.

But a check on the Skalnate Pleso *Atlas of the Heavens* showed it to be the 12th-magnitude galactic cluster NGC 2158, located at 6^h 04^m.3, +24° 06′, with a diameter listed as four minutes of arc. In my instrument it was much brighter and larger than this. Except for a sentence in Webb, I can find no mention of it in the usual observers' books. But a few days after finding it, I received a letter from William Davey, in New York State, who saw it with an 8-inch. His description agrees with mine, "marvelous, glowing, and mysterious little cluster." Other observers I have asked have been unable to find it at all.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.

MARS AND THE MOON

On February 6th the moon occulted Mars for West Coast observers. Although the actual occultation was not visible from my location, and clouds interfered during the early evening, I did obtain some photographs of the objects near each other in the sky. My 6-inch reflector, of 75 inches focal length, was used at the prime focus, exposures of $\frac{1}{5}$ second being made on Panatomic X film. Development was in DK50 at full strength for eight minutes.

Robert T. Dobson superimposed three moon images to show its motion past Mars on the evening of February 6th.

The accompanying composite picture is made of three superimposed images of the moon taken at 6:55, 7:00, and 7:05 p.m., Eastern standard time. The Mars images are evenly spaced, and show the rapid motion of the moon relative to the planet; the arrow points in the other direction, indicating the time sequence of the Mars images.

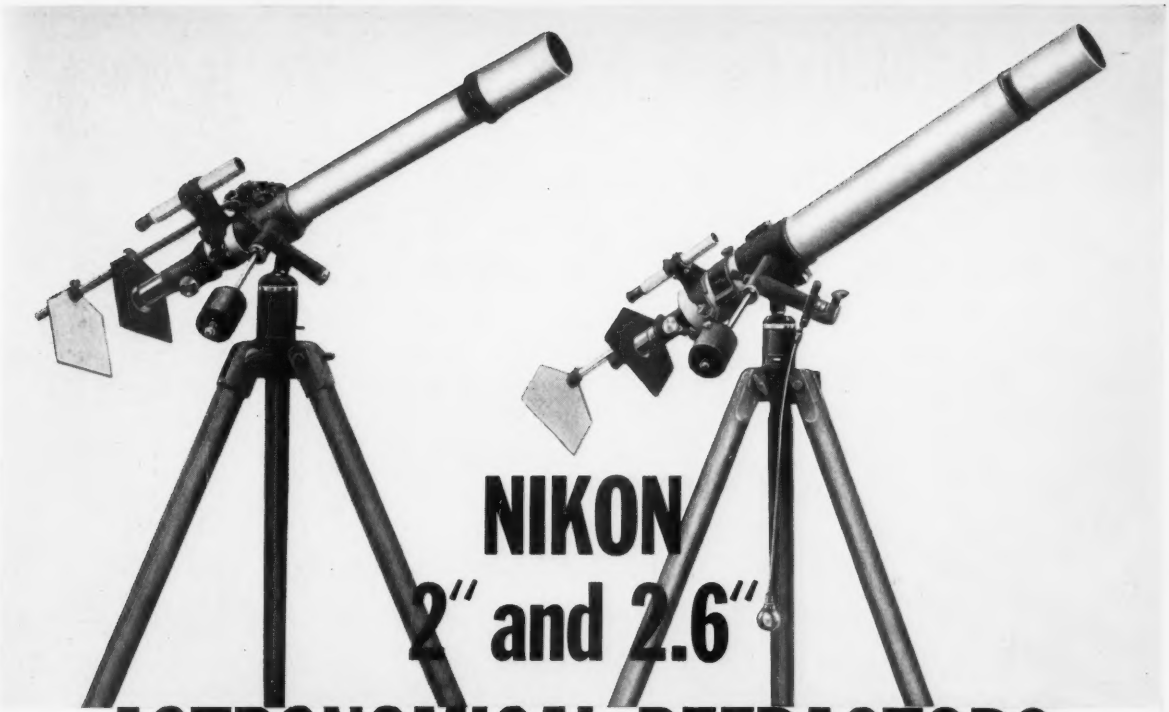
ROBERT T. DOBSON
2720 Dewey Ave.
Rochester 16, N. Y.

SUNSPOT NUMBERS

January 1, 157, 150; **2,** 137, 180; **3,** 169, 203; **4,** 198, 195; **5,** 194, 217; **6,** 209, 244; **7,** 153, 215; **8,** 145, 196; **9,** 124, 156; **10,** 99, 146; **11,** 102, 145; **12,** 118, 148; **13,** 110, 123; **14,** 85, 114; **15,** 66, 90; **16,** 54, 90; **17,** 81, 100; **18,** 138, 126; **19,** 151, 150; **20,** 142, 150; **21,** 138, 155; **22,** 144, 183; **23,** 123, 171; **24,** 138, 201; **25,** 155, 170; **26,** 151, 146; **27,** 125, 134; **28,** 115, 125; **29,** 96, 117; **30,** 88, 88; **31,** 98, 92. Means for January: 129.1 American, 152.3 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

Predictions of the smoothed monthly sunspot numbers have been supplied by Dr. M. Waldmeier for the coming months: April, 171; May, 169; June, 167; and July, 164.



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Walter Palmstorfer's meteor flared near the end of its path. The "W" of Cassiopeia is in the upper left, the Andromeda nebula near the bottom.

An Austrian Amateur Photographs a Bright Meteor

ON THE NIGHT of August 9, 1956, I was occupied in photographing Cassiopeia and the star fields around it with my f/3.5, 75-mm. camera, when a meteor suddenly appeared, moving almost toward me, so it seemed. Seconds later, after it had died out, its train appeared like a faint nebula among the stars.

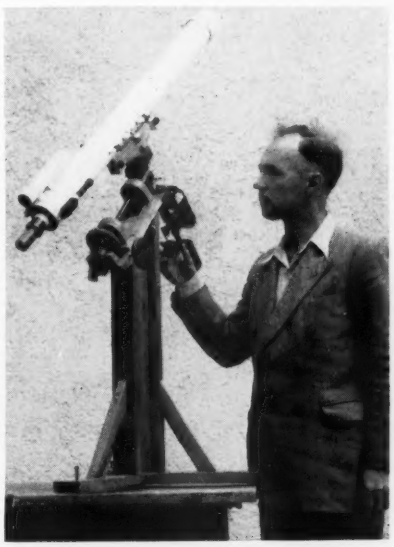
The exposure was continued for about 40 minutes, on Ilford HPS film. As I have no accurate watch, I could not fix the meteor's time of appearance, so the photograph will have no value for meteor study, but I think it is very lucky for an amateur astronomer to get such a bright meteor on film.

The camera was mounted on the small refractor shown. I am planning to make a 5-inch refractor, and wonder if I could purchase a used lens of good quality in the United States, having about 50 or 60 dollars available for this purpose.

I am a member of the "Astronomical Community of Linz," but in Austria there is no good astronomical paper, only small local ones. Furthermore, amateur astronomers are very thinly spread over our country. It would be of great value to me to correspond now and then with an American amateur.

From 1943 to 1946 I was in the United States at prisoner-of-war camps in Nebraska, Colorado, and Virginia. Since that time I have had a strong, true feeling for your country and your way of living.

WALTER PALMSTORFER
Pettenbach, Oberösterreich
Austria



Mr. Palmstorfer with the refractor on which the camera was mounted.

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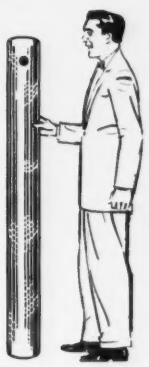

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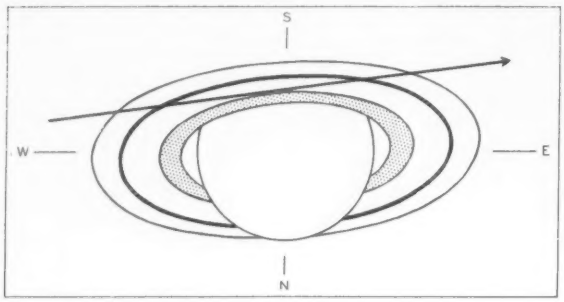
SATURN TO OCCULT A STAR

In the early morning of April 28th in North and South America (also in Australia), observers may watch Saturn and its rings pass in front of an 8th-magnitude star. This unusual event can be easily viewed in telescopes of medium size. The star is BD −20° 4568, which is of spectral type *K5*.

Details of this occultation are given in the 1957 *Handbook* of the British Astronomical Association. The following times are valid for Lick Observatory, near San Jose, California, and apply along the West Coast of the United States. The star will disappear behind Saturn's outer ring at 0:07 a.m., Pacific standard time, and reappear from the other side of the outer ring at 3:44 a.m.

In the East, low altitude and dawn will interfere with observations of the emergence of the star from behind the rings. At Washington and Montreal, disappearance behind the outer ring is scheduled for about 2:58 a.m. Eastern standard time.

The only satellite of Saturn that is about as bright as the star being occulted is Titan, which will then be located southeast of the planet at a distance equal to nearly three times the longest diameter of the ring system.



The path of the star BD −20° 4568 behind the rings of Saturn on April 28th. The crepe ring is shaded, and Cassini's division is the heavy line between the outer ring A and ring B. The field of view is inverted.

APRIL METEORS

The Lyrid meteor shower may be observed at its maximum on the morning of April 22nd, when about 12 meteors per hour should be visible after midnight under good sky conditions. Sky illumination from the last-quarter moon in Capricornus will interfere slightly. The Lyrid meteor tracks appear to diverge from a point about 7° southwest of Vega, at right ascension 18^h 12^m, declination +34°.

E. O.

OCCULTATION PREDICTIONS

April 16-17 **Omega^1 Scorpii** 4.1, 16:04.3 −20-33.3, 17. Im: **A** 6:13.6 −1.4 −0.6 135; **B** 6:10.7 −1.4 −0.3 130; **C** 6:10.9 −1.1 −1.3 149; **D** 6:04.1 −1.1 −0.5 139; **E** 6:01.7 . . . . . 171. Em: **A** 7:21.8 −2.1 +0.5 245; **B** 7:21.0 −2.0 +0.4 250; **C** 7:07.9 −2.5 +1.4 234; **D** 7:07.8 −2.1 +0.9 243; **E** 6:31.6 . . . . . 216.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**LO** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

MOON PHASES AND DISTANCE

First quarter	April 7, 20:32
Full moon	April 14, 12:09
Last quarter	April 21, 23:00
New moon	April 29, 23:54
First quarter	May 7, 2:29

	April	Distance	Diameter
Perigee	12, 1^h	226,100 mi.	32′ 51″
Apogee	23, 21^h	251,500 mi.	29′ 31″
	May		
Perigee	9, 3^h	229,200 mi.	32′ 24″

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

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ZEISS refracting telescope, 3″ aperture, 3 orthoscopic oculars (21x, 47x, 95x), also sun and erecting prism oculars. Slow-motion control handles provided for both of the co-ordinates. Altazimuth mount and tripod. Sacrifice, $160.00. Dr. J. S. Zabner, 617 Granby St., Norfolk, Va.

WANTED: Used observatory regulator clock, in case, or movement only. 60-beat pendulum, weight powered, or electric wound. Jesse H. Wootton, Room 897, 20 N. Wacker Drive, Chicago 6, Ill.

TELESCOPE: Rich field, 4″ paraboloidal pyrex mirror, f/4. 1″ ocular, excellent condition. Best offer. John Myer, 1913 Ridge Ave., Zanesville, Ohio.

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YOUR MIRROR correctly parabolized. Unfinished mirrors ground, polished, figured to your specifications. Parabolized mirrors. A. Zaleski, 84-30 56th Ave., Elmhurst 73, N. Y.

TELESCOPE, 100-mm. lens. Slow-motion controls, tripod-mounted, finder, eyepieces up to 500 power. Two years old, hardly used. Cost $975.00. Sell for $375.00. V. Corradini, 1148 La Rosa Rd., Arcadia, Calif.

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ACHROMATIC OBJECTIVE, 4″, cost $69.00; mounting, $11.95; eyepiece mounting, $13.95; total cost, $94.90. All for only $70.00. L. W. Herring, 2000 N. E. 24th St., Ft. Lauderdale, Fla.

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BINOCULARS: Bushnell wide-angle 7 x 35-mm. Rangemaster, spotless, $99.50, save $50.00. Rare astro lenses: Eastman Aero Ektar 12″, f/2.5, $149.50; Bausch and Lomb Aero Tessar, 24″, f/6, $89.50; Bausch and Lomb extra wide-angle Metrogon, 6″, f/6.3, with 9 x 10 plate camera, $99.50. Details from Dr. H. E. Paul, 119 N. Broad St., Norwich, N. Y.

IMPORTED refractor objective, 4″, f/15, fine condition, mounted in cell with dust cap, $100.00 f.o.b. 20 x 50 imported binocular, individual focus with case, like new, $40.00 f.o.b. Samuel Linn, Morrill, Nebr.

TELESCOPE: 12½″ f/5 combination Newtonian-Cassegrainian, Caltech-Porter design, see page 449 *Amateur Telescope Making*. Excellent optics, pendulum-controlled clock drive, reversible electric slow-motion punch-block control for both axes. Three-power turret finder, 2 camera attachments, sun diagonal, solar eyepiece, projecting reticle, 7 eyepieces. Replacement cost $8,000.00. Will crate and ship for $3,750.00. Photos available. B. A. Wacek, 2901 Remington Ave., Baltimore 11, Md.

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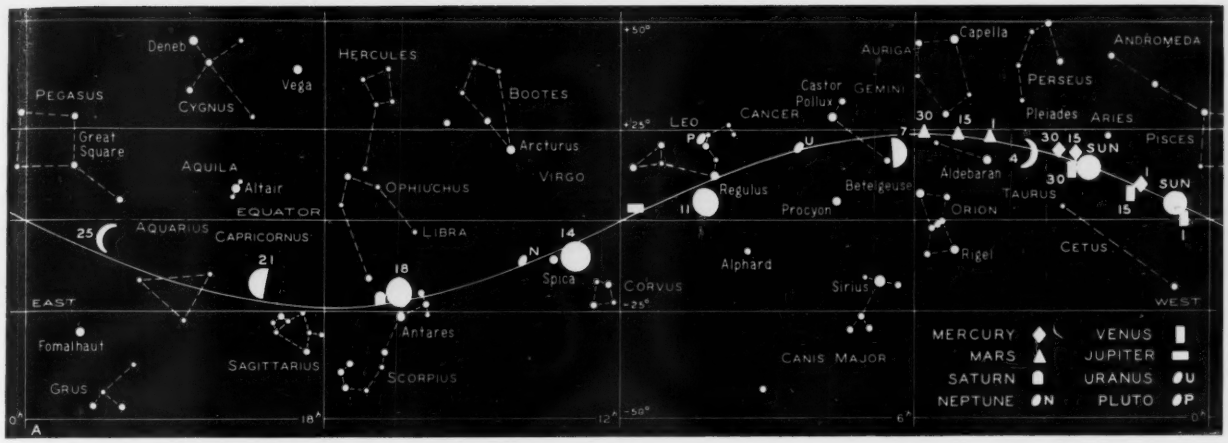


THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

The sun will be eclipsed on April 29-30. The eclipse will be annular in northeastern Russia and the Arctic Ocean, but partial phases may be seen over most of eastern Asia, Alaska, western Canada, and the northwestern United States.

Mercury may be easily viewed during its most favorable evening apparition this year, and the Graphic Time Table of the Heavens (January issue) shows that for a period of nearly two weeks, from April 8th to 21st, the elusive planet will be above the horizon after the end of evening twilight, visible in a dark sky. It will be as bright as magnitude −1.2 at the beginning of the month, setting one hour after the sun. Greatest eastern elongation of 19° 45′ occurs on the 15th, with the planet at magnitude +0.3 and remaining in the sky 1¾ hours after the sun sets. The planet will fade in brightness and rapidly approach the sun during the last week of April.

Venus reaches superior conjunction with the sun on April 14th, and hence will not be seen this month.

Mars crosses the eastern half of Taurus in April. On the 3rd, it passes nearly seven degrees north of Aldebaran. Mars will then be half a magnitude fainter than the star, and comparison of these two reddish objects may be of interest.

Jupiter is on the meridian at 10 p.m. local time in mid-April, remaining visible most of the night. The planet continues in retrograde, or westward, motion, and is near the boundary of Virgo and Leo. At midmonth Jupiter shines at magnitude −1.9, and its disk has an equatorial diameter of 43″.1; the satellites continue to provide an ever-changing scenic view for small telescopes.

Saturn can be seen rising in the southeast shortly before midnight in early April. Located in southern Ophiuchus, the planet is still retrograding. During the second half of the month it appears at magnitude +0.4, with the rings inclined 26° and their northern face visible. A close conjunction of Saturn and the moon takes place on April 18th at 2:41 UT, with the planet only 18′ south for a geocentric observer; there will be an occultation in the equatorial regions of the Eastern Hemisphere, but the moon will have passed the planet by the time they rise for observers in the United States. On the 28th, Saturn occults the star BD −20° 4568 (see preceding page).

Uranus sets about three hours before sunrise, but can best be viewed in the evening when it is near the meridian, about 4° west of the Beehive cluster in Cancer. Easily visible in binoculars, this 6th-magnitude object ends its slow retrograde motion on the 10th and resumes eastward travel. Uranus passes western quadrature with the sun on April 23rd.

Neptune will be at opposition to the sun on April 21st, its distance from our earth 2,724 million miles. Appearing at the 8th magnitude, this planet is in retrograde motion about 3° west of Kappa Virginis.

E. O.

VARIABLE STAR MAXIMA

April 3, R Draconis, 163266, 7.6; 3, R Indi, 222**867**, 8.0; 4, V Monocerotis, 061**702**, 7.1; 7, R Virginis, 123**307**, 6.9; 9, R Cancri, 081112, 6.8; 10, R Geminorum, 070122a, 7.1; 12, R Serpentis, 154615, 6.8; 15, U Orionis, 054920a, 6.6; 17, Z Puppis, 072**820**b, 7.9; 22, R Ursae Majoris, 103**769**, 7.6; 24, RT Sagittarii, 201**139**, 7.9; 26, R Aquilae, 190108, 6.3.

May 4, R Cacli, 043**738**, 8.0.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MINIMA OF ALGOL

April 1, 9:08; 4, 5:57; 7, 2:46; 9, 23:36; 12, 20:25; 15, 17:14; 18, 14:03; 21, 10:52; 24, 7:41; 27, 4:30; 30, 1:19. May 2, 22:08; 5, 18:57.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Predictions for April were published last month on page 250.

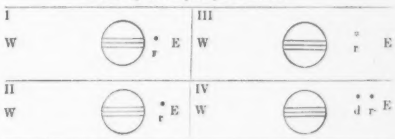
JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

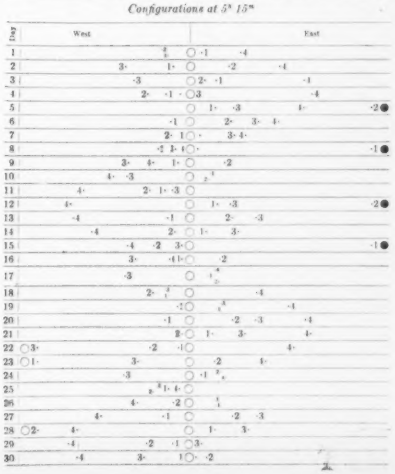
In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.

APRIL

Phases of the Eclipses of the Satellites



Configurations at 5^h 15^m



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STARS FOR APRIL

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of April, respectively; also, at 7 p.m. on May 7th. For other dates, add or subtract ½ hour per week.

The seven bright stars that form the Big Dipper, a part of Ursa Major, are now conspicuous, high in the northeastern sky. Follow the curve of the Dipper's handle downward to locate brilliant, orange Arcturus, and white Spica in the constellation Virgo.

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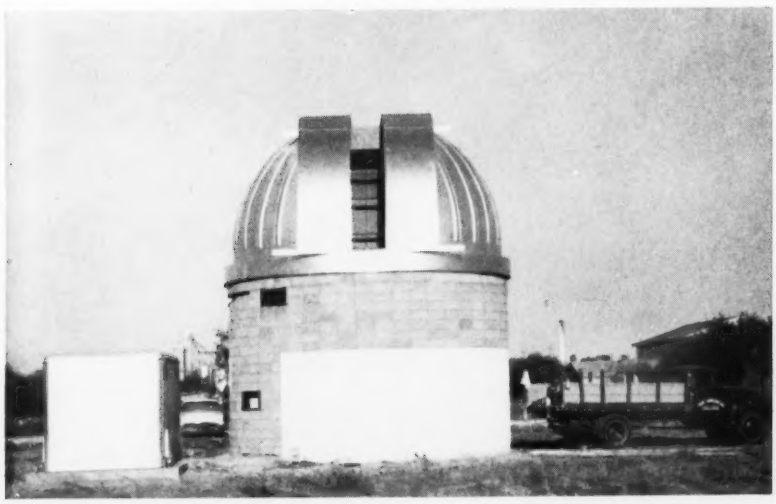

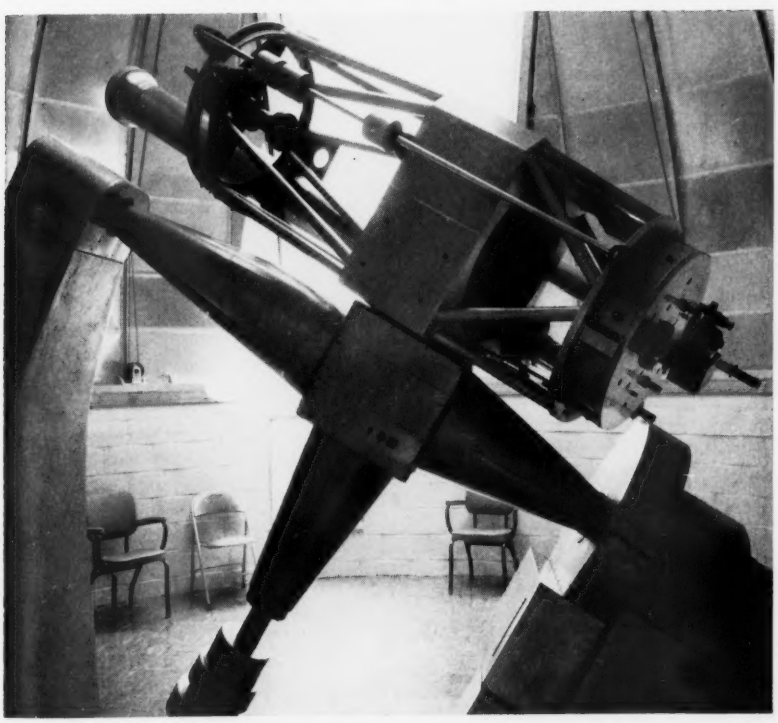

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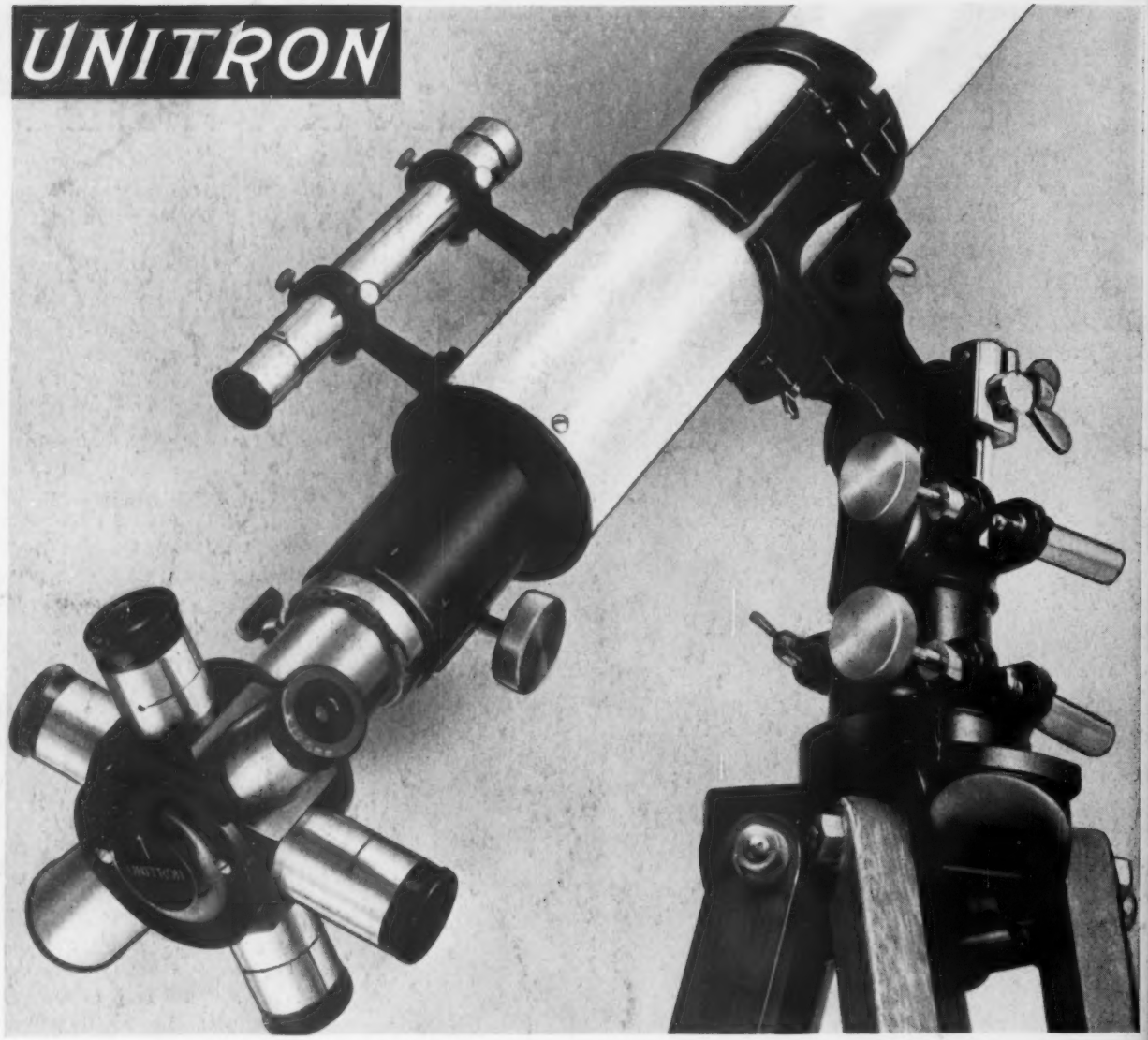

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